The Biodiversity and Management of Aspen Woodlands:

Proceedings of a one-day conference held in Kingussie, Scotland, on 25th May 2001

Edited by Peter Cosgrove and Andy Amphlett

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Foreword

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These proceedings are the result of hard work and enthusiasm of many individuals and organisations involved in action and research into the biodiversity and management of Aspen woodlands in the UK. This interest and effort culminated in a one-day conference held at The Duke of Gordon Hotel, Kingussie in the heart of Aspen country on Friday the 25th May 2001. Over 120 people interested in the biodiversity and management of Aspen woodlands attended the conference.

The quality of both the presentations and the poster sessions convinced the organisers of the need to publish this material as a fitting permanent record of the conference. Most of the papers in these proceedings were presented in one form or another at the conference, with a small number of additional important papers invited from other contributors. It is hoped that these proceedings have captured the expertise and interest of the various specialists and enthusiasts that was so evident on the 25th May 2001. In particular, it is hoped that these papers will stimulate further positive action and research into the biodiversity and management of Aspen woodlands in the UK.

As a focus for future action, Trees for Life have offered to establish and host a web-site and central information resource on Aspen that is easily accessible to land managers, researchers and the general public. If you would like to become more involved in Aspen action please visit Trees for Life's website: http://www.treesforlife.org.uk

Finally, we would like to thank the sponsors and partners; Aberdeenshire Council, Butterfly Conservation, Cairngorms Local Biodiversity Action Plan, Cairngorms Partnership, Forest of Spey Project, Forestry Commission, Highland Council and the Highland Local Biodiversity Action Plan Partnership, RSPB, Scottish Natural Heritage (SNH), and Woodland Trust Scotland, who came together to make this conference happen. We are very grateful to the proceedings authors and photographers who contributed their time and efforts so freely. In particular, special thanks are due to Tom Prescott of the RSPB, and to Anne Elliott and Peter Beattie of SNH for organising such a successful and enjoyable event.

Overview

As a woodland type, or as a significant component of other woodlands, Aspen is restricted, in the Scottish Highlands, to a very limited number of sites mainly in the North-east. Here its local abundance, in parts of Badenoch and Strathspey especially, making a striking contribution to the landscape, seems at odds with its lack of formal recognition in current national vegetation classifications.

With one exception, the papers in these proceedings concentrate on Aspen in the North east Highlands, where the conference and fieldtrip were held. Links could and should be made with Scandinavian ecologists, who view Aspen, especially old individual trees, as keystone components in preserving biodiversity in boreal forests. There, Aspen is a focus of current research, e.g. as part of the University of Helsinki's Biodiversity in Boreal Forests project (http://www.helsinki.fi/science/biobof/).

In the Scottish Highlands, Aspen is particularly associated with well drained, often moist, mineral soils. Here it was a very early post-glacial colonist (before Scots pine) and has persisted in mixed woods with Birch, Hazel, Willow and Rowan, which are probably of great antiquity. It also occurs more rarely, as stands within the native pinewoods.

As a tree species, Aspen is widespread across the British Isles appearing to be especially frequent in South-east England (Perring and Walters 1962). Examination of a selection of recent county Floras from England which map Aspen at the tetrad scale reveals Aspen to be very frequent in some areas, ranging from just 8% of tetrads in Devon (Ivimey-Cook 1984) to 35% in Kent (Philp 1982) and a remarkable 41% in Sussex (Hall 1980). Do large Aspen stands occur outside the Highlands? The scant descriptions in these Floras make it hard to place Aspen into an ecological context, but the resource seems to be very large elsewhere, warranting more attention.

Rare species confined to, or with nationally important populations on Aspen include flies, moths, beetles, fungi, lichens and mosses, as described in subsequent papers. In terms of practical nature conservation, a number of these species are in need of emergency “first aid”. The invertebrates, as is so often the case, are in the greatest need of targeted (and monitored) management. They include a number of species with critically low populations which utilise relatively ephemeral components of the total Aspen resource, e.g. the decaying cambial layers under the bark of large diameter logs on the ground, or the foliage of Aspen suckers less than 1m high. A number of lichens and one moss are similarly restricted to just a few individual Aspen trees, though in the medium term they may be able to persist on these trees.

In a turn around from usual situations, these proceedings lack information (with one notable exception - European beaver) on the vertebrate fauna associated with Aspen. For example, we appear to know next to nothing about the bird species and communities associated with Aspen in this country. Elsewhere in Europe, Aspen woodland and its dead wood resources attract several species of hole nesting birds, including various species of woodpeckers, some of which are absent from the UK. Aspens are also used by other, perhaps unexpected, species such as Capercaillie (*Tetrao urogallus*). The ‘Bird species of UK Aspen woodlands’ paper has yet to be written, but breeding records of Buzzard (*Buteo buteo*), Great spotted woodpecker (*Dendrocopus major*) Redstart (*Phoenicurus phoenicurus*) and Redwing (*Turdus iliacus*) from the afternoon fieldtrip suggests it is an area worthy of further investigation.

For all of these ‘Aspen dependent’ species, chance events or uninformed management could be devastating for local populations. All require regular population and distribution monitoring and habitat management trials aimed at securing populations. It is beholden on specialists, advisors and site managers to consider the implications of any proposed actions (or inaction) on other taxonomic groups or habitats. Mellings and Compton report the apparent loss of the BAP weevil, *Byctiscus populi*, at one site due to the removal (for unspecified conservation reasons) of Aspen scrub. Though statistically unlikely, creation of dead wood to increase potential breeding sites for threatened Diptera could lead to a loss of a similarly threatened lichen or moss. Practically, we either accept that risk (not recommended!) or we ensure that adequate baseline surveys are carried out prior to management, and that site managers know the exact location of important trees. Unfortunately, the current lack of skilled field lichenologists and bryologists is a critical problem for facilitating informed management decisions.

Peter Quelch's goal of protecting, regenerating and expanding all existing Aspen woods, stands and trees, as well as planting into new areas deserves support. However, it has to be remembered that it will be decades before some components of the overall Aspen habitat will have increased, e.g. large diameter trees and snags. Clonal variation is almost certainly a significant determining factor for the epiphyte communities of Aspen and quite plausibly for other groups e.g. Diptera. New plantings of Aspens should follow the protocol adopted by Trees for Life (Watson) and include material from as wide a range of locally occurring clones as possible.

Much attention has centred on the importance of the largest Aspen stands, as being the only instances whereby natural processes can maintain a continuity of supply of key micro-habitats. Rothero highlights the possible significance of smaller stands and wayside Aspens for bryophytes, and Coppins *et al.* (2001) have demonstrated the outstanding importance of some small Aspen stands for lichens. Such examples should be targeted for survey and conservation.

Given that Aspen will sucker so freely, it is obvious that exclusion or other control of grazing animals will be an important tool to expand existing stands. Complete exclusion of browsers may not be desirable, as the maintenance of successional habitats with associated pollen and nectar sources may be of value to foraging adult invertebrates. Aspen stands occur in a wide variety of contexts and important habitats may occur within the bounds of a projected Aspen expansion zone. Complete exclusion of grazing from such areas may be damaging to other interests. Again, adequate survey prior to formulating management plans is required.

Several contributors discussed and highlighted the grants and financial assistance available to land managers to progress practical action for Aspen and its dependent species. Specific examples of the practical work carried out to date are presented, including the challenges of reconnecting isolated Aspen stands to facilitate important ecological processes, such as species dispersal or gene flow. As a number of authors point out, we are only just beginning to identify and understand the complex biodiversity associated with Aspen in the UK, and clearly much is still waiting to be discovered.

Finally, Anne Elliott's paper illustrates that interest in Aspen is not just the domain of ecologists and specialist researchers. Aspen has strong cultural links for the people of the Scottish Highlands and their support will be crucial if any action for Aspen is to be successful. We should not lose sight of the fact that Aspen woodlands are a beautiful and striking feature of the Highland landscape, and worthy of conserving for that reason. Indeed it can be argued that Aspen helps improve the quality of life for local residents and helps make the Highland area special for visitors and tourists.

Aspen seems to have survived as an ancient remnant up to now largely by default, rather than by design. These proceedings provide compelling evidence of why this situation should change and how Aspen conservation and management should move up the UK conservation agenda in the future.

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The ecology and history of Aspen woodlands

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Introduction

This paper gives a quick overview of Aspen, both as a tree species and as a rare woodland type in Scotland. The ecology of Aspen is well covered by Rick Worrell, along with other selected papers and booklets. Much has been written about the folklore of Aspen (Elliott, this volume) and why it is such an enigmatic and well loved tree.

This paper will examine where Aspen occurs naturally in today's landscape, and then to ask if we are satisfied with the status quo. If we are not, what greater part could Aspen play in Scotland's woods and forests, and what actions should be considered on its behalf? At present, Aspen is a well liked but 'Cinderella' species, somewhat neglected, and yet with an unrealised potential. Recognition of its values for biodiversity have emphasised Aspen's importance, and this gives the context for this paper.

Aspen in the Biodiversity Action Plan (BAP) process

Simple woodland classifications tend to label woodland types by their dominant tree species, i.e. Oakwoods, Birchwoods, Pinewoods and so on. We can therefore recognise 'Aspen woods' where locally Aspen predominates in certain stands of semi-natural broadleaves in Badenoch and Strathspey, alongside Birch, Rowan, Hazel, Sallow and Alder.

The UK BAP process uses such a classification in selecting the main native woodland types and allocating targets for action (*for an overview of woodland classifications see Hall and Kirby, 1998*). But what is the status of those native woodland types which are *not* given BAP plans?

- ***Birchwoods*** – after many years of discussion it has now been agreed that upland Birchwoods should have their own Habitat Action Plan (HAP).
- ***Hazel*** is not covered separately in the BAP process, despite some lobbying on behalf of the western coastal hazelwoods, which are exceptionally rich habitats for oceanic bryophytes and lichens. Certain rare lichens characteristic of this habitat, (e.g. *Arthothelium macounii*, or *Pseudocyphellaria norvegica*) then become surrogates in the BAP process for the habitat they depend on, since they have been given Species Action Plans (SAP).
- ***Juniper*** – this native shrub species is covered by having its own SAP, but no HAP.
- ***Aspen*** is mentioned in the SAPs for three invertebrate species which depend on it as a habitat, (*Hammerschmidtia ferruginea, Byctiscus populi* and *Epione parallelaria),* and two bryophytes (*Orthotrichium* sp.), but Aspen has neither its own HAP or SAP. Aspen woodlands are however recognised as important habitats in some Local Biodiversity Action Plans (LBAP), e.g. the Cairngorms LBAP.

Aspen in woodland classifications

In the National Vegetation Classification (NVC) (Rodwell 1991), Aspen is described as a component of upland Ashwood (W9b), but even then only occurring rarely. Aspen is also mentioned as an infrequent component in several lowland woodland types: W5, W6, W8, W10, and W16.

Aspen woodlands are not recognised as a distinct woodland type in either NVC, or in the Peterken Stand Type classification (Peterken 1993), where Aspen is associated with the Rowan/Birch stands of Type 12A. Rackham (1986) recognises Aspen woodlands as a subset of Peterken's Birch/Hazel woods, at least for East England. In their classic survey of native pinewoods, Steven and Carlisle (1959) record Aspen as rare or occasional in most of the pinewoods they surveyed, but never abundant. Interestingly they record more than usual Aspen in Glen Strathfarrar pinewoods, which appear to be one of the most natural woodland remnants in the country today.

Aspects of Aspen ecology

Like Birch and other successful colonisers, Aspen can tolerate a wide range of soil types, from lime-rich sites to acidic heaths (for example, Aspen suckers are spreading onto acidic heath at Crannach pinewood, Bridge of Orchy). Like Oak and Ash, Aspen actually prefers good well drained mineral soils, a site type that it finds in greater areas in Badenoch, Strathspey and Deeside. While sites that it occupies are often moist, it is not a wet woodland species in the same way as Alder or the Willows, or even Bird cherry. Aspen grows at a wide range of altitudes, from sea level (coastal Aspen at Assynt and on Rum) to high altitude gullies almost to the tree-line.

Aspen history

Aspen has an ancient history in Scottish woodlands, being a very early coloniser, arriving with Birch, Sallow and Rowan during the pre-Boreal period 10,000 years ago, earlier than Hazel, and before Scots pine began to dominate. All this happened well before Oak, Alder, Ash, Elm and Holly joined the flora. I see Aspen not so much as a rare and neglected *woodland type*, but more as a tree species which is now under-represented as a component of natural woodland types in Scotland, despite its ancient lineage. I also find it significant that Aspen is host to so many specialist species, despite the fact that the tree itself is not now very common or in extensive stands. To me this dependency indicates a very long ecological association, and this is backed up by the history of Aspen in Scotland.

Aspen and ancient woodlands

Aspen seems to be strongly linked to ancient woodland sites, both in Scotland and in England where it is also a somewhat rare component of usually ancient woodlands (Rackham 1986, 1990). Indeed, I would go further and suggest that Aspen in Scotland is actually an ancient woodland indicator species. Most examples that I find are linked to ancient woodlands, large or small. For example, I recently came across Aspen in the Ryvoan Pass (Glenmore Forest) in a very mixed old-growth stand at high elevation, alongside veteran Scots pine, Juniper and Rowan, as well as very old grey Sallow and Alder. Aspen has strong connections, not only with ancient woodland patches, but sometimes to the tiny woodland refugia of the most natural origins.

Aspen in Europe

In Europe and Scandinavia, where Aspen is more abundant, it is usually as a component species of the northern sub-boreal temperate forest zone (Worrell 1996), rather than as a woodland dominant on certain soil types (compared to say, Oak or Beech). Its natural place seems to be in the small group of broadleaved associates in northern coniferous forests, along with Birch, Rowan, Sallow, and Alder, where together they typically occupy about 15-20% of the forest, alongside the Pine and Spruce (Peterken 1996).

Reasons for current distribution of Aspen

Why has Aspen survived where it is to be found today even sometimes after all other tree species have gone? The reasons for Aspen's ability to survive, albeit in low numbers, include:

- Aspen is actually a poor coloniser (in modern times at least), for while it can produce viable seed this is a rare occurrence.
- Aspen trees are dioecious, so individual trees and even whole clones are either male or female. As individuals become separated from the opposite sex, it is not surprising that Aspen does not reproduce well in its currently fragmented condition.

- Nevertheless, Aspen is very good at self-perpetuation on a local scale by producing masses of suckers in response to felling, windthrow, fire or other disturbance. It seems that vegetative reproduction keeps Aspen going in the same locality almost indefinitely.
- While grazing animals do eat the suckers (it is more palatable than Alder, but less so than Ash and Elm), sufficient survive to grow into new trees, unless grazing pressure is kept at very high levels.
- Aspen is not an inherently rare species like the various Whitebeams for example, partly because it has wide soil and altitude tolerance.
- Aspen has not traditionally been a valuable species for its timber, bark, or coppice shoots (unlike Oak and Hazel) and so has not been deliberately protected or cultivated.
- Aspen has probably been reduced in status partly through poor seeding ability (compared to Birch and Sallow), combined with susceptibility to grazing, but also an ***inability to form veteran trees*** (unlike Oak, Holly, Ash, Pine and Alder, which can all survive as stems of many centuries age). Long-lived trees have more time in which to set viable seed and produce new generations during lulls in grazing pressure. The reason why Aspen cannot live a long time and form a huge hollow and ancient stem must surely be that the soft white wood is not durable against rot fungi (unlike Oak and Pine for example).
- If it were not for its suckering ability, Aspen may well have been lost entirely from Scotland.

Are we happy with Aspen's current distribution?

So, apart from the relatively small number of Aspen dominated woods in Badenoch, Strathspey and Deeside, Aspen is a survivor in small patches over most of Scotland. It is found on the sea cliffs of the west coast, in ancient grazed pinewoods in the central Highlands, in remote refugia like the lochside screes of Loch Muick, in the Border cleugh woodland remnants, and in the forgotten corners of many an ancient woodland.

Should Aspen be left alone to inhabit these sparse niches - the remote and craggy woodland refugia? Should Aspen continue to be treated as a somewhat enigmatic tree rarity, a minor species, mainly of interest to woodland historians and romantics as a ghost of the once great natural woodlands? Or does Aspen have a wider role in Scottish woods and forests?

A possible new scenario for Aspen?

Lets look again at the role Aspen plays in, for example, central Swedish forests, where Aspen forms a constituent of the broadleaved component of the mixed pine/spruce forests, along with Birch, Sallow and Alder.

Why could we not encourage both Birch and Aspen as a normal component of Scottish upland forests, up to a proportion of say 25%, rather than the current five or 10% normal maximum? The biodiversity and landscape benefits would be high, and Aspen timber grown in forest conditions is (like other Poplars) straight and utilisable, though not of high value (less than Birch, similar to Alder?). Birch and Sallow regenerate profusely, Alder readily coppices even in the face of moderate deer numbers, while Aspen suckers after felling. So the species in this group can perpetuate themselves at low cost, and all are relatively fast growing.

Conclusion

I think that Aspen would be sold short if we continued to confine it to woodland refugia and regard it as a rarity. There is evidence that it was once a great component of Scottish natural woodlands, and there seems to be no good reason why, with help, it could not be so again. It is time for a 'Comeback Code' for Aspen!

Actions needed to bring Aspen back into its rightful place could include the following:

- Protecting, regenerating, and expanding where possible, all existing Aspen woods, stands and trees.
- Careful planting of Aspen (of both sexes) into some degraded semi-natural woodlands where it is missing
- Planting Aspen into forestry restock areas in sufficient numbers, that Aspen becomes a self-perpetuating component of a group of mixed broadleaves which between them would cover 15-25% of the gross area of many upland and lowland conifer forests.

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Fungi and Aspens: Promoting Biodiversity
Aspen friends and foes

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It has been estimated that about 80% of all the organic energy on the Earth is locked up in wood of various kinds. This enormous store of energy is under constant attack, both when the trees are alive and more so when they are dead: from fungi, bacteria, insects and smaller animals. (Ryvarden 2001).

Foremost in the relationships with trees are the fungi and these play several different roles, not all of them detrimental to the health of the tree and some also provide food – for insects and other invertebrates, as well as mammals.

The fungi can be classified under three main headings:

Categories of Forest Fungi		
Mycorrhizal	Endo-	*Important for most (all?) plants*
	Ecto-	*Important for most trees, e.g. Aspen*
Saprophytes or Detrivores		*Litter decomposers*
Pathogenic/parasitic		*Principal causes of tree death*

The Mycorrhizal species are essential for the healthy growth of the tree. These fungi are of two sorts: **endo-mycorrhizal** and **ecto-mycorrhizal**. The hyphae of the latter sheath the tree's roots and, by breaking down material in the forest soil, they provide the tree with nitrogenous and other nutrients, including mineral trace elements. In exchange, the fungus receives carbohydrates manufactured by the tree during photosynthesis. Endomycorrhizal species are the most widespread, but their presence is not revealed by the formation of fruitbodies on the soil surface. These fungi enter the plant root cells forming specialised inclusion bodies, where exchange of nutrients occurs.

With Aspens, the ectomycorrhizal fungi are more important, and fairly specific associates in this category include familiar toadstool shaped fungi such as *Leccinum aurantiacum, Leccinum duriusculum and Lactarius controversus.* These are the friends of the Aspen, helping it to grow.

The second group of fungi are the **Saprophytes** and these include both host specific and cosmopolitan species. They are the litter decomposers, reducing fallen leaves, twigs and other already dead woody material to humus, a principal part of forest soils. These fungi include some that look like familiar toadstools with lamellae ("gills"). Others are poroid fungi (the Polypores), releasing their spores from pores instead of lamellae.

Some others that help to decay the woody material look rather like paint splashes and sheets of fungal tissue adhering to the surface but loose at the edges; and yet others form hard warty growths on twigs and branches. These are the Corticioid fungi. They do not have lamellae or pores; instead, they form amorphous sheets of spore bearing tissue covering the surface of logs and twigs.

Examples of detrivores specific to Aspen are the Polypores: *Ceriporiopsis anaerina, Antrodia malicola and mellita***,** and the Corticioid***:*** *Peniophora polygonia*. The two *Antrodias* mentioned have not yet been found in Britain, but it is hoped that they will be found in Scotland.

The cosmopolitan species are legion; for example, many *Mycena* species. One that was found in an Aspen grove on The Royal Society for the Protection of Birds' (RSPB) Insh Marshes Reserve last November may be a new species for science requiring description.

The Poroid and Corticioid fungi are among the dominating species in the decay of Aspens. In two Norwegian studies of the species occurring on cut and fallen logs, it was found that most of them were Polypores and Corticioids (Table 1).

Table 1. Taxonomic diversity of wood decaying fungi on Aspen

Locality	**Number of species**					
	Polypores	Corticioids	Agarics	Hetero-basidio-mycetes	Other	Total
South Norway (Andersen - 1995) 123 Logs	21 (14.2%)	64 (42.6%)	43 (29%)	16 (10.3%)	6 (3.9%)	155
South Norway (Hermansen 1974-76)	31 (27.7%)	81 (72.3%)				112

Note that in one of these studies, the Aspen logs yielded 155 species of fungi, an indication of the value of lying timber for biodiversity.

The diversity of the fungal species increases as the wood decay proceeds: in the early stages of decay relatively few fungi colonise the wood, but as defensive substances are removed by early colonisers, a succession of species become involved. By the last stage, when the trunk is losing its shape completely, a great number of species have inhabited the former tree, during its decay cycle.

Some of the rarer fungi fruit only sporadically, with long gaps of many years between appearances of the sporocarps, although they are presumably present throughout in the vegetative state. In several long-term studies, while some species fruited regularly, others were only recorded once. It has also been found that some fungi can only invade decaying wood after a pioneer species has overcome the wood's armoury of defensive chemicals and started the partial decay. (Niemelä *et al*. 1995).

So far, nearly 100 species of fungi have been recorded on or with Aspen in Britain (Table 2), by members of the British Mycological Society – mostly in England, reflecting where most mycologists live or collect and where Aspen is not considered a common tree. The authors anticipate increasing the number of species recorded from Aspen in the coming years.

The third group, the **Pathogenic fungi**, are especially interesting, and include several species that are specific to Aspen. They are not friends of the Aspen but do great things for biodiversity. They include the group known as Rusts, as well as larger poroid fungi, the Polypores, often referred to as Bracket fungi.

Aspen is the host for several species of Rust (*Melampsora spp.),* which cause decay spots on the leaves and some will blacken and kill the growing tips of new shoots. Heavy infestation can result in defoliation of the Aspen. These fungi thus reduce the growth rate of the tree and obviously are detrimental to the life cycle of insects that feed on the young leaves and growing shoot tips, such as the Dark-bordered beauty moth (*Epione vespertaria*).

A spectacular flower parasite is *Taphrina johansonii,* and this obviously interferes with seed production where it occurs. It is probably of limited significance in Badenoch and Strathspey, where flowering is rare – although in 2001 the trees were flowering and the *Taphrina* was found locally in Strathspey.

Another small parasite is the Ascomycete, *Encoelia fascicularis*, which can be found erupting like small brownish black cups from the bark of living trees and on fallen branches on the ground. This fungus causes carbonising rots.

The wood decaying parasites include a significant Polypore, *Phellinus tremulae*, which is responsible for the death of most Aspens. It is a “white rot” type fungus, decomposing both the lignin and the cellulose. The wood from decayed trees has little economic value. Sporocarps can be found erupting as wedge shaped brackets from the trunks of Aspens, or else as a coating on the underside of branches at the point where they emerge from the main trunk – the “branch creepers”.

This fungus, which is the most serious pathogen of Aspen, was previously not recorded from Britain until last year, when it was found for the first time on the RSPB Insh Marshes Reserve (Emmett and Emmett 2001) – and so it is not even on the Red Data List for fungi. It was thought that Britain did not have any Aspen trees large enough to support it. In Fennoscandia, where Aspen is much more common, it usually occurs on large and old trees. In Badenoch, however, it has been found on comparatively young trees – the diameter at breast height of the smallest of the infected trees measured so far, is under 20cm and the largest is about 50cm.

Since the first recording of *Phellinus* on the Insh reserve, it has been found at many sites in the Badenoch and Strathspey area: at three places in Kingussie, at Kincraig, at Loch an Eilein on the Rothiemurchus estate, Granish near Aviemore, at two sites near Grantown on Spey and westwards towards Laggan, and it has also been found on the RSPB Abernethy Forest reserve and across the Cairngorm massif near to Balmoral. It is likely to be found at other Aspen sites and this has been confirmed from other areas; for example, recent records from Glen Affric (Watson-Featherstone this volume).

The Aspens that grow on the poorer soils, for example on stony moraines, seem to produce sporocarps more readily than those that grow on the richer, damper sites closer to water bodies. These findings confirm similar ones made by mycologists in Finland and Norway.

The problem in recording fungi is that most of them are ephemeral and there may not be a friendly mycologist on hand when a fungus fruits! Fortunately, *Phellinus tremulae* is perennial, the fruit bodies are persistent and one can see the annual growth phases on the fruit bodies. They are not easy to spot in the early stages of their growth though, often looking like a thumbnail on the trunk. The fungus is typically a parasite of living trees, but fruit bodies remain alive for a few years after the death of the host tree. It is said not to form new fruit bodies on dead trunks (Balaban and Kotlaba 1970). The current authors, however, have observed fruit bodies that have apparently formed after trees have fallen.

Entomologists hunting rare saproxylic insects in decaying Aspens, record a sweet smell in the soft decay material that the larvae feed on. Cultures of the *Phellinus* are unusually interesting in that they emit a sweet smell like Oil of Wintergreen, due to the presence of methyl benzoate, methyl salicylate, benzyl alcohol, linalool and ethyl benzoate (Collins and Halim 1972). It is likely that mycelium of the *Phellinus* is present in the decomposing sapwood which is home to the larvae of these invertebrates, and contributes these compounds to the mixture of smells.

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(For work by Andersen and Hermansen, see Ryvarden 2001)

Table 2. Species of fungi recorded in association with Aspen

Source: British Mycological Society Fungus Recording Database

Arcyria cinerea	*Armillaria bulbosa*	*Auricularia mesenterica*
Badhamia panicea	*Bjerkandera adusta*	*Bolbitius vitellinus*
Boletus erythropus	*Brevicellicium olivascens*	*Byssomerulius corium*
Ceriporiopsis aneirina	*Chalara cylindrosperma*	*Clitopilus prunulus*
Comatricha nigra	*Coprinus disseminatus*	*Cortinarius*
Cortinarius crocolitus	*Cortinarius decipiens*	*Creopus gelatinosus*
Crepidotus cinnabarinus	*Crepidotus mollis*	*Cristinia rhenana*
Cryptodiaporthe populea	*Cryptosphaeria populina*	*Cylindrobasidium laeve*
Cyrtidula hippocastani	*Daedaleopsis confragosa*	*Dothiora sphaerioides*
Drepanopeziza	*Encoelia fascicularis*	*Enteridium lycoperdon*
Epicoccum nigrum	*Exidia nucleata*	*Flammulaster carpophiloides*
Ganoderma applanatum	*Gymnopilus junonius*	*Hebeloma*
Hebeloma sacchariolens	*Hymenoscyphus caudatus*	*Hymenoscyphus immutabilis*
Hyphodontia gossypina	*Inonotus radiatus*	*Kirschsteiniothelia aethiops*
Laccaria laccata	*Lasiosphaeria ovina*	*Leccinum aurantiacum*
Lactarius controversus	*Leccinum duriusculum*	*Leccinum fuscoalbum*
Leccinum populinum	*Lenzites betulina*	*Leucostoma niveum*
Leucostoma persoonii	*Linospora ceuthocarpa*	*Macrotyphula juncea*
Massarina emergens	*Melampsora allii-populina*	*Melampsora epitea var. epitea*
Melampsora larici-populina	*Melampsora populnea*	*Mitrophora semilibera*
Mollisina acerina	*Mycena acicula*	*Mycena galericulata*
Mycena pura	*Nemania serpens*	*Oxyporus populinus*
Panus conchatus	*Patellariopsis clavispora*	*Peniophora lycii*
Peniophora polygonia	*Peziza udicola*	*Phaeocalicium praecedens*
Phanerochaete velutina	*Phellinus ferruginosus*	*Phellinus tremulae*
Pholiota squarrosa	*Phomopsis putator*	*Physarum robustum*
Platystomum compressum	*Pleurotus ostreatus*	*Polydesmia pruinosa*
Rosellinia aquila	*Scopuloides hydnoides*	*Stictis radiata*
Taphrina johansonii	*Taphrina populina*	*Tomentella crinalis*
Trametes pubescens	*Trichoderma viride*	*Tricholoma fulvum*
Tricholoma populinum	*Troposporella fumosa*	*Tympanis spermatiospora*
Typhula setipes	*Uncinula adunca var. adunca*	*Valsa sordida*
Venturia macularis	*Xerocomus subtomentosus*	

The importance of Aspens for lichen

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Aspens differ greatly, both structurally and chemically, from the majority of Highland woodland trees and in particular from Birch and Scots pine. In Strathspey, especially, they provide a very important niche substrate for epiphytes that is otherwise virtually absent. One hundred and thirty species of lichen and 12 lichenicolous fungi have been recorded on Aspen in Strathspey (Table 1).

The bark of Aspens can be both fissured and smooth. The characteristic 'diamond-shaped' rough parts provide a coarse substrate favouring some species such as the 'strap-like' green *Ramalina spp.* some of them up to 25cm long. The smooth areas host a different suite of lichens such as *Lecidella elaeochroma* and *Pertusaria* or *Arthonia spp.* which are crustose. Older trees tend to be more rough and fissured, and bark on the oldest can even superficially resemble that of Oak. Scots pine, for example, cannot host these species and birches and pines typically hold the genera *Bryoria, Usnea* and *Hypogymnia,* which, themselves, are less common upon Aspens.

Different parts of each Aspen can also provide a variety of microhabitats. On the lower parts of the trunk, usually overgrowing bryophytes, are lichens such as *Peltigera membranacea*, a 'dog-lichen', so-called because the Velcro-like rhizinae attaching it to its substrate are said to resemble dogs' teeth. At the other end of the tree, small lichens such as *Rinodina sophodes* subsist on small twigs.

The most significant feature of Aspen bark is its low acidity. Whereas Scots pine and Birch are typically around pH 3.2-3.5 (ranges respectively 3.4-3.8 and 3.2-5.0), Aspen bark is pH 5-6 (Mikko Kuusinen, Annales Botanici Fennici, 1994). Interestingly, some Strathspey Aspen clones host lichen epiphytes more typical of acidic substrates, while others hold those favouring more neutral or alkaline conditions. Further research may reveal the reason for this being natural variation in bark pH. There is also evidence that Aspens probably provide a naturally enriched substrate. Therefore, species that prefer nutrient-rich, basic habitats grow on them such as *Xanthoria parietina* (probably the best-known British lichen occurring as orange splodges on most old asbestos roofs) and *Physconia distorta,* a whitish-grey placodioid species with pruina that resemble caster sugar. Both of these have prominent jam-tart shaped apothecia (fruiting bodies). It can be noted that the *Xanthoria* plants show a preference for the western facing sides of Aspens and one method of quickly spotting Aspen stands from afar is to look for any tree sporting orange lichens.

The longest established stands, as with most woodlands, are those which have the richest lichen assemblages. At Invertromie (Strathspey), the Aspen seminar study area, there appear to have been a succession of pulses of vigorous Aspen regeneration. One is presently underway following some fencing to exclude deer and rabbits. Another occurred in the late 1980s when sheep grazing ceased and at least two others; one around 30-50 years ago and another, earlier one, are evident resulting in the varied age structure seen today.

The most species rich Aspen stands hold some very scarce and endangered lichens. The Aspen seminar field trip study area at Invertromie, for example, revealed one new UK lichen species *Arthonia patellulata,* another not seen for over 150 years with the apposite specific name *Lecanora populicola* and two more lichens, each confined to less than 20 UK sites. One is *Sclerophora pallida,* a vulnerable Red Data Book (RDB) lichen resembling minute ginger coloured pinheads which is found on the dry under-hangs of boughs and trunks. The other a RDB (vulnerable) and 'Schedule 8' (legally protected) rarity called *Pannaria ignobilis*. This has an oddly disjunct distribution from Norway to the Mediterranean and is found locally in central Scotland.

Another interesting feature is the presence of several lichens normally considered more 'oceanic' or 'western' in their distribution. Examples include *Pannaria conoplea, Degelia plumbea* and the large, leafy lungworts *Lobaria pulmonaria* and *L. scrobiculata* which are relatively common along the western seaboard of Scotland from Argyll to Assynt, but scarcer well inland amid the central Highlands of Scotland (F Dobson, Lichens [distribution maps], 2000). These species and others demonstrate yet another important feature in that they are all closely associated with, and some confined to, ancient woodlands. Ecological indices have been developed defining lichen species linked to native pinewoods and western Scottish broadleaved woods and it may be possible, in future, for a similar version to be developed providing better evaluation of the ecological continuity of Aspen woods. It is clear already from the range of bryological, lichenological and entomological taxa present, that many Aspen woods show strong evidence of very long ecological continuity.

Each taxonomic group speaker used the Aspen seminar as a forum to make a plea for feedback from delegates and lichens are no exception: an extremely rare species resembling a small dark pinhead about a millimetre long called *Phaeocalicium praecedens* apparently exists only on Aspen twigs. If something resembling this is found, please collect and send a small sample specimen provided there is plenty locally present to Sheila Street.

The study of lichens associated with Aspens in Britain is in its infancy. Only recently, Brian and Sandy Coppins discovered the first UK occurrence of a species called *Bacidia igniarii* on Aspen. Further research in Strathspey since the Aspen seminar has revealed a yet more diverse lichen flora living upon Aspens including two more new species to the UK: *Caloplaca ahtii* and (once it is confirmed) *Rinodina laevigata* plus the best UK population of the attractive, and now rare, RDB critically endangered Schedule 8 lichen *Caloplaca flavorubescens.* This research is also beginning to provide insight into the processes involved with this special and complex symbiotic association. Judging by the diverse range of specialist epiphytes or invertebrates that these Aspen stands sustain, they are evidently ancient ecosystems requiring further study.

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Table 1. Strathspey Aspen Lichen species list

Annotations:

Column 2: Status

RDB (CE)	=	Red Data Book species (Critically Endangered)
RDB (V)	=	Red Data Book species (Vulnerable)
Sch. 8	=	Listed on Schedule 8 of the Wildlife and Countryside Act
Nr	=	Nationally rare species (recorded in only 15 or fewer 10km squares)
Ns	=	Nationally scarce species (recorded in only 16-100 10km squares). Other status details are written in full or annotated with superscript references.

Column 3: Substrata

Pp	=	*Populus tremula*
Al	=	*Alnus glutinosa*
B	=	*Betula* spp.
C	=	*Corylus avellana*
J	=	*Juniperus communis*
L or ~L	=	lignum
S	=	*Salix* spp.
Sb	=	*Sorbus aucuparia*
T	=	terricolous
Sx	=	saxicolous
-by	=	on bryophytes
-st	=	on stumps
-tw	=	on twigs or thin branches

Column 4: Relative abundance (RA)

D = Dominant, A = Abundant, F = Frequent, O = Occasional, R = Rare

Species	***Status***	***Substrata***	***RA***
Arthonia mediella	*Ns*	*Pp*	*R*
A. muscigena	*Ns*	*Pp-by*	*R*
A. patellulata	*Nr – new to UK*	*Pp*	*R*
A. punctiformis		*Pp,C*	*O*
A. radiata		*Pp,C*	*O*
A. subfuscula	*Nr*	*Pp*	*R*
A. vinosa		*Pp*	*R*
Bacidia absistens	*Ns*	*Pp*	*R*
B. arceutina		*Pp*	*O*
B. igniarii	*Nr*	*Pp*	*O*
B. naegelii		*Pp*	*O*
B. rubella		*Pp*	*O*
B. vermifera	*RDB(CE) Nr*	*Pp*	*R*
Biatoridium delitescens	*RDB(V) Nr*	*Pp*	*R*
Bryoria fuscescens		*Pp,B,Sb,L*	*F*
Buellia disciformis		*Pp,B,C,Sb*	*F*
B. griseovirens		*Pp,C*	*O*
B. punctata		*Pp*	*R*
Calicium glaucellum		*Pp,L*	*R*
C. viride		*Pp*	*O*

Species	***Status***	***Substrata***	***RA***
Caloplaca ahtii	*Nr - new to UK*	*Pp*	*R*
C. cerina		*Pp*	*F*
C. cerinella	*Ns*	*Pp*	*F*
C. cerinelloides	*Ns*	*Pp*	*O*
C. ferruginea	*Ns*	*Pp*	*F*
C. flavorubescens	*RDB(CE) Sch.8, Ns*	*Pp*	*R*
C. obscurella		*Pp*	*O*
Caloplaca phlogina		*Pp*	*R*
Candelariella xanthostigma		*Pp*	*R*
Catillaria nigroclavata	*Ns*	*Pp*	*O*
Catinaria neuschildii	*RDB(V) Nr*	*Pp*	*R*
C. aff. atropurpurea	*Ns*	*Pp*	*R*
Chaenotheca chrysocephala		*Pp*	*R*
C. furfuracea		*Pp*	*R*
Chrysothrix candelaris		*Pp,B,Al*	*F*
Cladonia chlorophaea		*Pp*	*O*
C. coniocraea		*Pp- and B-by*	*F*
C. fimbriata		*Pp-by*	*R*
C. glauca		*Pp,B*	*R*
C. pyxidata		*Pp base*	*F*
Cliostomum griffithii		*Pp*	*R*
Collema occultatum	*Ns*	*Pp*	*R*
Degelia plumbea		*Pp*	*O*
Evernia prunastri		*Pp,B,C, Sb*	*F*
Fuscidea arboricola	*Ns*	*Pp*	*R*
Hypocenomyce scalaris		*Pp*	*R*
Hypogymnia physodes		*Pp,B,C,S,Sb*	*A*
H. tubulosa		*Pp, B*	*F*
Lauderlindsaya acroglypta	*Ns*	*Pp*	*O*
Lecania cyrtellina	*Ns*	*Pp*	*R*
L. sambucina	*Nr*	*Pp*	*R*
Lecanora carpinea		*Pp,C*	*F*
L. chlarotera		*Pp*	*A*
L. confusa		*Pp*	*R*
L. conizaeoides		*PpL*	*R*
L. expallens		*Pp, B, C*	*A*
L. persimilis	*Ns*	*Pp*	*O*
L. populicola	*[RDB(EX)]Nr*	*Pp*	*O*
L. pulicaris		*PpL,B*	*F*
L. rugosella	*Ns*	*Pp*	*F*
L. sambuci	*Ns*	*Pp*	*O*
L. symmicta		*Pp*	*R*

Species	Status	Substrata	RA
L . turgidula		PpL	R
Lecidella elaeochroma		Pp,C	A
f. soralifera		Pp-tw	R
L. lobificans		Pp	O
L. umbricola	Ns	Pp	R
Lobaria amplissima (as Dendriscocaulon umhausense – the cyanobacterial morph)		Pp	R
L. pulmonaria		Pp,C	R
L. scrobiculata		Pp,Sb	R
Lopadium disciforme	Ns	Pp	R
Megalaria grossa		Pp	A
Micarea nitschkeana		PpL	R
Mycoblastus fucatus		PpL,C	O
Nephroma laevigatum		C,Pp	O
Ochrolechia androgyna		Pp,Sb	A
O. microstictoides		Pp,JSb	O
O. szatalaensis	Ns	Pp	O
O. turneri		Pp	R
Opegrapha herbarum		Pp	R
O niveoatra		Pp	O
O. ochrocheila		Pp	R
O. rufescens		Pp	R
Pannaria conoplea		Pp	R
P. mediterranea		Pp-fallen	R
P. ignobilis	RDB(V), Sch.8, Ns	Pp	R
P. rubiginosa		Pp	R
Parmelia exasperata		Pp,B-tw	F
P. glabratula subsp. glabratula		Pp,Al	A
P. saxatilis		Pp,B,C,Sb	A
P. subaurifera		Pp, B,	F
P. sulcata		Pp, B, Al,C	A
Parmeliella triptophylla		Pp	O
Peltigera collina		Pp,C	R
P. membranacea		T,Pp-by	O
P. praetextata		PpL,T-by	F
Pertusaria amara		Pp,Al,C,Sb	A
P. coccodes		Pp	R
P. coronata	Ns	Pp	O
P. flavida		Pp,Sb	R
P. hemisphaerica		Pp,Sb	R
P. leioplaca		Pp, C	F

Species	***Status***	***Substrata***	***RA***
P. pertusa		*Pp,A,B*	*F*
P. pupillaris		*PpL,J,Sb*	*R*
Phaeophyscia orbicularis		*Pp*	*F*
Phlyctis argena		*Pp,C,Sb*	*A*
Physcia adscendens		*Pp*	*O*
P. aipolea		*Pp*	*A*
P. leptalea		*Pp*	*O*
P. stellaris		*Pp*	*O*
P. tenella		*Pp*	*A*
Physconia distorta		*Pp, C*	*A*
Platismatia glauca		*Pp,B,C,J,Sb, L*	*A*
Pseudevernia furfuracea		*Pp,B,J,Sb,L*	*F*
Pyrrhospora quernea		*Pp*	*R*
Ramalina farinacea		*Pp,Al,C*	*A*
R. fastigiata		*Pp*	*R*
R. fraxinea		*Pp*	*F*
Rinodina efflorescens	*Ns*	*Pp,Sb*	*O*
R. ? levitate		*Pp-tw*	*R*
R. sophodes		*Pp-tw*	*O*
Schismatomma graphidiodes	*RDB(V) Sch.8, Nr*	*Pp*	*R*
Sclerophora pallida	*RDB(V) Ns*	*Pp,Sb*	*R*
Scoliciosporum chlorococcum		*Pp*	*O*
Sphaerophorus globosus		*Pp,Al,B,Sb*	*R*
Sticta limbata		*Pp*	*R*
Tephromela atra		*Pp*	*F*
U. hirta		*Pp,B*	*O*
U. subfloridana		*Pp,B,C,J,Sb*	*F*
Xanthoria parietina		*Pp*	*A*
X. polycarpa		*Pp*	*O*

Lichenicolous fungi (all on lichens growing on Aspen in Strathspey)

Arthonia subfuscicola in apothecia of *Lecanora carpinea,* not previously recorded in UK since 19th century

Arthonia sp. in apothecia of *Lecanora populicola.* Similar to *A. intexta* in having 1–2-septate ascospores

Dactylospora parasitaster associated with *Biatoridium delitescens*

Laeviomyces pertusariicola on *Pertusaria leioplaca*

Lethariicola sp. on *Pertusaria coronata.* Possibly the same undescribed species as previously found in Scotland on *Pertusaria hymenea*

Lichenodiplis lecanorae on *Caloplaca cerinella* and *Lecanora persimilis*

Muellerella lichenicola on *Tephromela atra*

Phaeosphaerobolous alpinus on *Lecanora carpinea*

Phoma physciicola on *Physcia stellaris*

Stigmidium congestum in apothecia of *Lecanora chlarotera*

Stigmidium pumilum on *Physcia aipolia*

Vouauxiella lichenicola on *Lecanora chlarotera*

Other microfungi on Aspen

Amphisphaerella dispersella on Aspen bark
Dasyscyphius corticalis on Aspen bark
Hysterographium elongatum on Aspen lignum
Lahmia kunzei on Aspen bark
?*Melaspilea* cf. *proximella* on Aspen bark
Teichospora sp. on Aspen bark

Notes on Priority lichens and species new to the British Isles

Arthonia patellulata	Apparently the first correctly reported finds of this 'Aspen specialist' in the British Isles. Previous records have proven to be other species, although there is a 1968 record from Braemar that may be correct.
Bacidia vermifera	Status: RDB(CE). Previously recorded only from two 10km squares in Britain, both in Strathspey, one of which was Abernethy in 1980s. The finds during this survey increases the number of squares to four, and the first UK reports from Aspen.
Biatoridium delitescens	RDB(V) species, previously recorded from six 10km squares (four of which are Scottish). Not previously reported on Aspen from the UK.
Caloplaca ahtii	A recently described lichen from Fennoscandia and Alaska, where it is mainly found on Aspens. All the Scottish material is without apothecia.
Caloplaca flavovirescens	RDB(CE) and Schedule 8 lichen sparsely known from only a handful of isolated wayside trees, mostly Ash. Widely recorded in the 19th century, but now declined almost to extinction. Clais Eich and another site near Rothiemurchus are believed to be easily their best UK locations.
Catinaria neuschildii	RDB(V). The find at Kinchurdy is the fifth 10km square record in the UK, and the first from Aspen. Previous records are from Juniper and Oak.
Lecanora populicola	Until this survey RDB(EX). Not recorded in UK for over 150 years when it was last seen at Coltishall, East Norfolk. Seen at four sites.
Pannaria ignobilis	RDB(V) and Schedule 8. The discovery on a single old Aspen at Invertromie is the first and only record from Strathspey, and the first in the UK from Aspen. Its main populations are in the Great Glen and Strath Glass.
Rinodina laevigata *	If the identity is confirmed, this will be its first Scottish record and the first in Europe outwith Fennoscandia.
Schismatomma graphidiodes	This internationally rare RDB(V) and Schedule 8 species has its known world headquarters on the Oaks at Cawdor Wood near Nairn. Otherwise, it is known from only a handful of scattered, mostly Scottish localities.

* currently awaiting formal confirmation

Bryophytes on Aspens

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Introduction

Away from the oceanic woodlands of the west, where there is a rich and interesting bryoflora on all broadleaf species, interest in epiphytic bryophytes has tended to centre on those tree species known to have 'base-rich' bark, particularly *Fraxinus excelsior*, *Acer pseudoplatanus*, *Ulmus spp, Salix spp* and *Sambucus nigra*. These tree species often have a good assemblage of bryophytes, particularly when growing in relatively open sites, hence the value of wayside and parkland trees. To my knowledge, Aspen has mainly been celebrated as the host species for the single British record for *Orthotrichum gymnostomum* and it has certainly been undervalued.

Orthotrichum gymnostomum

Orthotrichum gymnostomum is a small, yellow-green, blunt-leaved moss which has a scattered distribution over much of northern and central Europe and also records from south-west Asia, Afghanistan and Newfoundland (Hill *et al.* 1994). Though it has been found on the bark of a number of different tree species throughout its range, most records come from species of *Populus* and through northern Europe most records are from old *Populus tremula* (Nyholm, 1979). In this sense, in Europe at least, it is probably more host-specific than other epiphytic bryophytes. Though sporophytes are apparently rare throughout its range, the plant does produce large numbers of gemmae, specialised means of vegetative reproduction, on its leaves, a feature it shares with the closely related *Orthotrichum obtusifolium*.

The solitary British record dates from 21st June 1966 when it was collected by J Dransfield in company with H.J.B. Birks and H.H. Lees near Loch an Eilein in the Rothiemurchus forest (Perry & Dransfield 1967). A small tuft consisting of about 15 stems was not recognised in the field and was collected. At first it was thought that the plant was *Orthotrichum obtusifolium,* but closer examination showed it to be *Orthotrichum gymnostomum*. After the discovery, other Aspens were searched but no further cushions were found. It would seem that the only cushion in that area had been collected, a sobering observation.

The site of the host Aspen for the 1966 record is not obvious from the description. The habitat description talks of *"open pine-birch woodland with occasional Aspens on a north-facing slope at about 800ft in altitude"* (Perry & Dransfield 1967), but unfortunately the six-figure map reference delineates a hectare on a south-facing slope near the loch margin. Perry and Dransfield opine that, given the frequency of Aspen in the Aviemore area, *Orthotrichum gymnostomum* should turn up elsewhere in the vicinity. Thirty five years on, that hope has yet to be realised and the plant is now classified as extinct in the Bryophyte Red Data Book (Church *et al.* 2001).

A number of competent bryologists have visited the Loch an Eilein area over the years and searched Aspens without success, but few have ventured further afield. Before giving up hope completely, it seemed a sensible idea to spend a small amount of time visiting some areas of Aspen in Strathspey and this suggestion was incorporated into a wider survey of 'Priority bryophytes' in Scotland, commissioned and funded by Scottish Natural Heritage. Other than the original locality, the sites to be visited were selected from a database of significant stands of Aspen compiled by the Malloch Society. It seemed sensible to look at as many Aspens as possible so only large stands were selected; at Invertromie, Insh, Torcroy, Creagan Breugach near Inverton, Speybank by Kincraig, Tomnagowan and Boat of Garten.

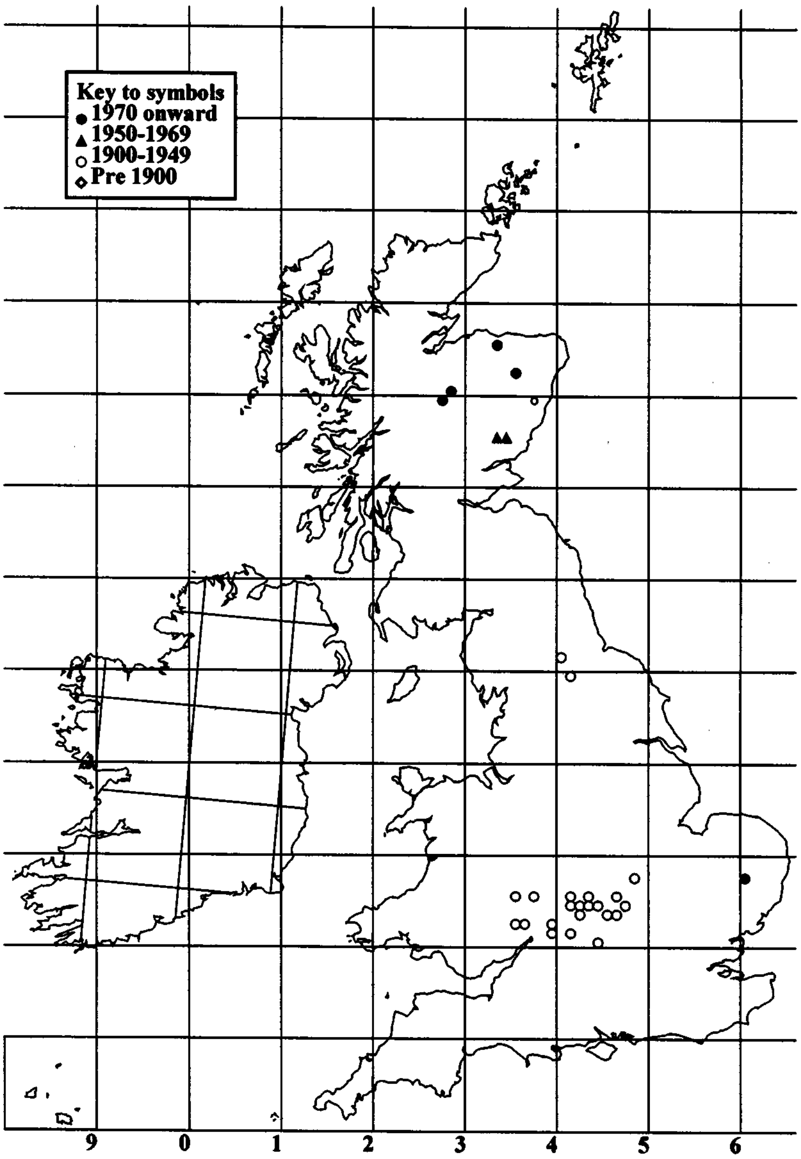
I had no more success at Loch an Eilean than other bryologists; the most likely site seemed to be Creag an Fhithich, the closest north-facing slope to the map reference with a few scattered Aspens, but a wider search was also made. Moving on to the other Aspen woodlands, two things were immediately apparent; Aspens had a much more diverse epiphytic bryophyte flora than I had realised, and searching all Aspens in a large woodland was not possible in the time available. Certainly more than 50% and probably more than 75% of the Aspens in the woods were checked, and it was the more bryophyte-rich trees that were targeted. On this basis I am reasonably convinced that *Orthotrichum gymnostomum* does not occur in the woodlands I visited. The general diversity of the flora is discussed below.

Orthotrichum obtusifolium

At Invertromie, one Aspen produced a small, blunt-leaved *Orthotrichum* species but this proved to be the closely related *Orthotrichum obtusifolium*. This species is very close to *Orthotrichum gymnostomum* and requires some familiarity with the group to distinguish it in the field. It has the same neat cushions with blunt leaves and differs mainly in the character of the leaf margins, plain or erect in *Orthotrichum obtusifolium* and curled in over the leaf surface in *Orthotrichum gymnostomum*. There are also critical differences in cell ornamentation that require a microscope but are diagnostic (Smith 1978).

The initial disappointment was hardly justified as *Orthotrichum obtusifolium* is listed on Schedule 8 of the Wildlife and Countryside Act and, prior to this survey of Aspens in Strathspey, had just one extant site in Britain, at Leith Hall near Huntly. The woodland at Insh produced a further tiny stand of *Orthotrichum obtusifolium* but disappointingly, no more populations were found at the other sites visited. A third locality was found on a group of Aspens at Inveruglas by David Chamberlain, walking back to Insh village from a visit to the site at Invertromie. During the ‘Aspen day’ afternoon fieldtrip, I found a further small stand close to the original tree at Invertromie and a subsequent search by David Long has revealed further stands, including one large one, on three more trees.

Orthotrichum obtusifolium, as the distribution map shows, has a much longer history in Britain than *Orthotrichum gymnostomum*.



Map 1. The Distribution of *Orthotrichum obtusifolium* in the British Isles

Orthotrichum obtusifolium was widespread in Britain in the 19th century, though it has always been rare. The reasonable presumption has been made that most of the English localities were casualties of increasing air pollution, though with a rare species, chance events will always play their part. Of the four relatively recent (post-1960) sites, three are in Scotland (Cortachy in Angus, Fochabers and Leith Hall). At Cortachy the plant grew on ‘parkland’ Elms which all seem to have succumbed to Dutch Elm disease, and this may also have been the fate of the Elm on which it was recorded at Fochabers. At Leith Hall there is a healthy population on some eight trees, both Elm and Sycamore, and this remains the best British population. At the English site in Norfolk, a single tuft was found on an elder twig in 1989, and shades of *Orthotrichum gymnostomum* was collected and has not been seen again.

The new populations near Insh have increased both the geographical spread of recorded localities and the number of host species. Historically, Ash has been the most favoured substrate in Britain followed by Elm and Sycamore, but in northern Europe and North America, *Orthotrichum obtusifolium* shows a marked preference for Aspen, so its occurrence on this tree in Scotland should be no real surprise. The sites at Invertromie and at Inveruglas are in relatively open woodland where light levels in summer remain quite high and all historic records come from similarly open sites. It may well be that further survey work on *Orthotrichum obtusifolium,* and possibly *Orthotrichum gymnostomum* as well, should target smaller stands of Aspen on more open sites rather than areas of woodland with a complete canopy.

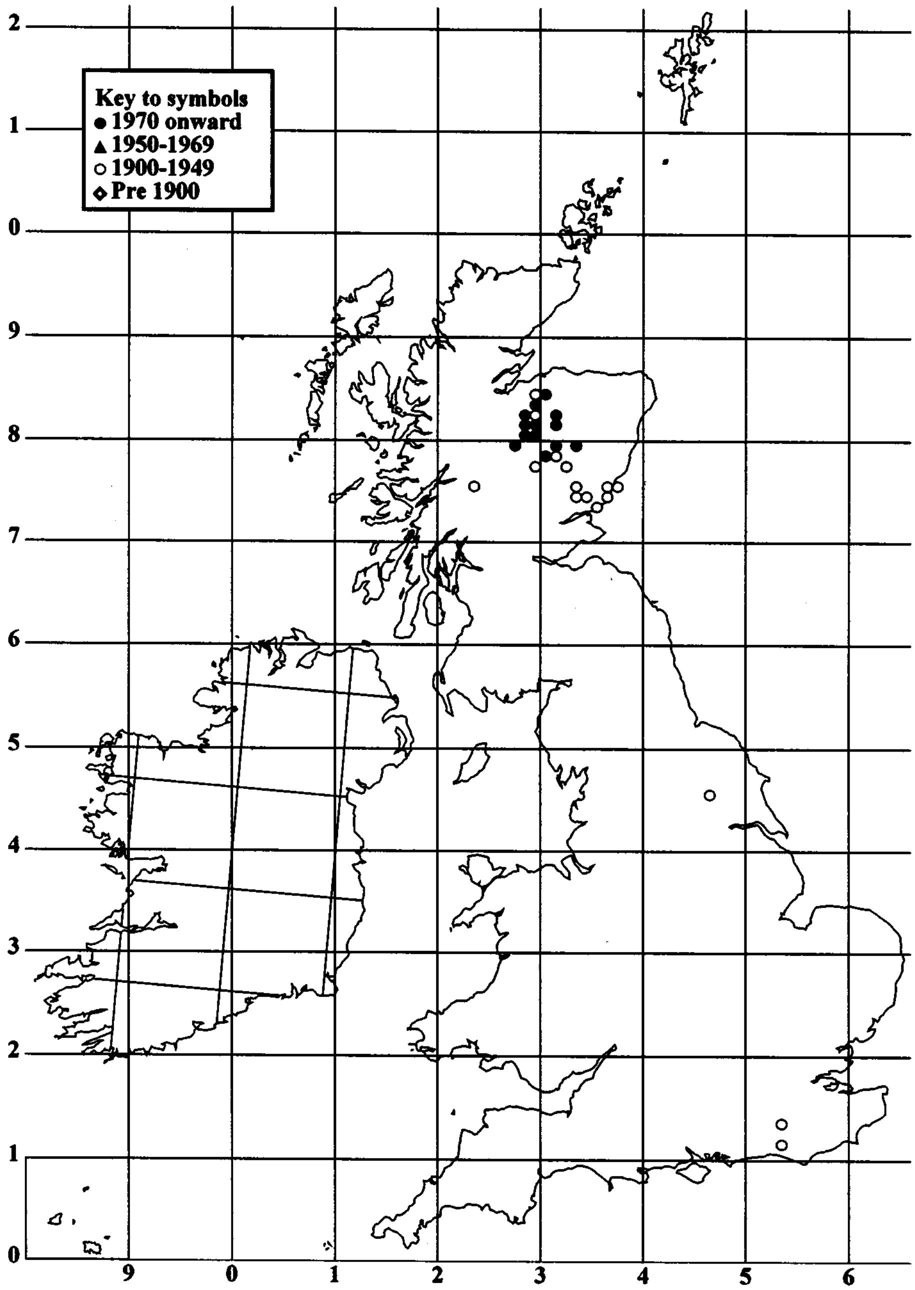
Other bryophytes on Aspen

The survey of large numbers of Aspen revealed that a good proportion of mature trees have an excellent epiphytic flora. Table 1 gives a list of bryophytes recorded from Aspen in Strathspey in 2000 and no doubt more could be added.

Table 1. Bryophytes recorded on Aspen in selected woodlands on Speyside in 2000

Liverworts	
Frullania dilatata	*Frullania fragilifolia* *Frullania tamarisci*
Metzgeria furcata	*Radula complanata*
Mosses	
Dicranum scoparium	*Dicranum fuscescens*
Homalothecium sericeum	*Hypnum andoi*
Hypnum cupressiforme	*Leucodon sciuroides*
Orthotrichum affine	*Orthotrichum lyellii*
Orthotrichum obtusifolium Nationally rare, Schedule 8	
Orthotrichum speciosum Nationally rare	
Orthotrichum stramineum	*Orthotrichum striatum*
Orthotrichum tenellum	*Syntrichia laevipila*
Ulota bruchii	*Ulota crispa*
Ulota drummondii	*Ulota phyllantha*
Zygodon conoideus	*Zygodon rupestris*
Zygodon viridissimus var viridissimus	

Apart from the excellent diversity of species, there are three important conclusions to be drawn from the list. The first is a simple observation, that Aspens in Strathspey are the centre of distribution for the nationally rare moss *Orthotrichum speciosum*. Given the restricted distribution of recent records of this species (see Map 2), its abundance on many Aspens in the woods visited is quite remarkable. The robust cushions with clearly visible capsules are a feature of most of the better trees, sometimes forming large stands. The second is that three of the mosses which occur regularly on Aspen in the area, *Ulota drummondii*, *Ulota phyllantha* and *Zygodon conoideus,* are ‘Atlantic bryophytes’ (see Hodgetts 1997), an affinity which is also reflected in the lichen flora.



Map 2. The distribution of *Orthotrichum speciosum* in the British Isles

The third observation is more subtle, but could be of considerable importance. The loss of Elms to disease, and the general loss of wayside and parkland trees over the past 100 years, has deprived epiphytic bryophytes of favoured sites, so much so that some species, like *Orthotrichum obtusifolium* but also *Orthotrichum pallens* and *Orthotrichum pumilum* are now endangered in Britain (Church *et al.* 2001). It may be that Aspens on open sites in the east of Scotland could have populations of these species that have been overlooked. Even if this does not prove to be the case, the substrate that Aspens provide for a good assemblage of regionally important species, which might otherwise be in decline, is a worthwhile discovery.

One further observation of epiphytic populations on Aspens is puzzling. Though some Aspens are clothed in a variety of epiphytic mosses, species which are known to need bark of a reasonably high nutrient status, others are almost devoid of bryophytes, except those which can cope with nutrient-poor conditions. So we have Aspens, close together and experiencing similar light and nutrient regimes, some having a flora similar to Ash or Elm and others to Birch or Alder. A similar situation seems to exist with the epiphytic lichen flora. One obvious explanation, given the structure of Aspen woodland, is that this may be a clonal difference, some trees being genetically different to others. Another possible explanation may relate to the sort of fungal infestation that the Aspen is subject to. Aspens seem particularly prone to damage and most large trees show signs of fungal invasion; does this affect the nutrient status of the bark or the run-off?

Conclusion

It is clear from the survey of a limited number of Aspens in 2000 that the importance of the species for epiphytic bryophytes has been distinctly under-estimated. Though *Orthotrichum gymnostomum* was not refound, the discovery of three new populations of *Orthotrichum obtusifolium*, the abundance of *Orthotrichum speciosum* and the diversity of epiphtyic mosses on Aspen fully justify the survey. Any increase in Aspen woodland will benefit bryophytes, and this is as true of smaller groups of trees as of larger woodlands, so there is a different emphasis here compared with the entomological interest. The epiphytic interest of the larger Aspens should be borne in mind when considering the management of the woodland for insects which require dead wood but sensible precautions should prevent any possible conflict.

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Aspen, a vital resource for saproxylic flies

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Saproxylic organisms are those that depend on dead wood at some stage in their life cycle. They vary from woodpeckers to fungi, but the most biodiverse groups are Coleoptera (beetles) and flies (Diptera). Over most of Europe saproxylic organisms are under threat, due to the removal of woodland cover and impoverishment of what remains (Speight 1989).

Over the past 12 years, members of the Malloch Society have been involved in a study of saproxylic Diptera in Scottish woodlands. In comparison with Coleoptera, Diptera are poorly known (Rotheray *et al.* 2001), and part of our aim was to redress this imbalance. Our emphasis was on finding breeding sites and rearing larvae.

During the study we visited over 300 woodlands throughout Scotland. We obtained 2061 records of 258 species in 32 families. Two hundred and six species were reared, many for the first time. We reared 53 red-listed species. In addition, we recorded nine species new to Britain and 10 new to science, which further demonstrates how poorly known this fauna is (Rotheray *et al.* 2001).

Most records came from common and relatively widespread boreal trees such as Silver birch, *Betula pubescens* E., Scots pine, *Pinus sylvestris* L. and also from Ash, *Fraxinus excelsior* L. However, another tree species was also important, Aspen, *Populus tremula* L. For example, we found that for red-listed and other significant species (defined here as ‘new to Britain’, ‘new to science’), Aspen was the third most important tree species after Birch and Pine of 22 tree species examined. It had three Red Data Book (RDB) category 1 “endangered” species reared from it, including the UK BAP Priority species, Aspen hoverfly *Hammerschmidtia ferruginea* (Fallen) (Diptera, Syrphidae) (Table 1). No other tree species had as many RDB 1 species associated with it (Rotheray *et al.* 2001). Altogether a group of 39 species were reared from Aspen, of which 14 were red-listed or otherwise significant.

Many of the red-listed and significant Diptera associated with Aspen appear to be confined to it. We did not rear them from any other tree species. Possibly these species will use other Willows and Poplars (Salicaceae) in different geographical regions, but this does not appear to be the case in Scotland. Thus, Aspen has a rich, specialised and unique fauna of saproxylic Diptera associated with it.

Table 1. Rare and notable insects bred from Highland Aspen

Species	Status**
Ecataetia christiei (Dipt.Scatopsidae)	New species
Mycetobia obscura (Dipt. Anisopodidae)	New to Britain
Lonchaea hackmani (Dipt. Lonchaeidae)	New to Britain
Medetera freyi (Dipt. Dolichopodidae)	New to Britain
Hammerschmidtia ferruginea (Dipt.Syrphidae)	RDB 1 (UK BAP)
Homalocephala biumbratum (Dipt.Ottitidae)	RDB 1
Strongylophthalmyia ustulata (Dipt.Tanypezidae)	RDB 1
Tachypeza heeri (Dipt.Hybotidae)	RDB 2
Tachypeza truncorum (Dipt.Hybotidae)	RDB 3
Medetera inspissata (Dipt.Dolichopodidae)	RDB 3
Brachyopa pilosa (Dipt.Syrphidae)	RDB 3
Gnophomyia viridipennis (Dipt. Tipulidae)	Notable
Clusoides apicalis (Dipt.Clusidae)	Notable
Stegena coleoptrata (Dipt.Drosophilidae)	Notable
Lonchaea peregrina (Dipt.Lonchaeidae)	Notable

Systenus pallipes (Dipt.Dolichopodidae)	Notable
Xylota tarda (Dipt.Syrphidae)	Notable
Criorhina ranunculi (Diptera Syrphidae)	Notable
Saperda carcharius (Col. Cerambycidae)	Notable

****** The status rating of the Dipteran species is based upon Falk (1991) and that of *Saperda carcharius* on Hyman and Parsons (1992).

The most important microhabitats used for breeding by saproxylic Diptera include tree-holes, exudations of tree sap, decaying sap under bark and decaying sapwood and heartwood. With the exception of exuding tree sap which is associated with live trees, all these microhabitats are found in stumps and live and dead trees and branches. Although some tree species exhibit a tendency to have more of one type of microhabitat than others, (e.g. tree-holes in Beech, decaying sapwood in Birch), all were features of most of the 22 tree species examined, including Aspen.

For saproxylic Diptera associated with Aspen, the most important microhabitat was decaying sap under bark. When a tree or branch dies one of the first stages in the decay process is bacterial decomposition of the cambial layers between the bark and the sapwood. In Aspen this process results in the gradual build-up of a dark, oily, pungent-smelling layer under the bark, and it often includes the inner layers of the bark. This decay process is common to all trees, but in no other species did we find a layer as thick and wet as in Aspen.

This layer develops patchily at first but will eventually, under suitable conditions of shade and light and perhaps other as yet unknown features such as the state of fungal decay within the wood, encompass the entire underside of the bark. Eventually the bark separates from the sapwood, cracks and this lets in air. Bacterial decomposition of the sap ends at this point and the oily layer dries out and becomes unsuitable. The dynamics of this decay process are unclear, but the initial build-up takes about two years and lasts for another three years or so. The thickness of the oily layer depends on the thickness of the branch or tree. In branches below about 10cm, the oily layer of decay is too thin to provide a breeding site for most of the important Diptera.

It is within this oily layer of trees and branches above 10cm diameter that most of the important saproxylic Diptera dependent on Aspen breed. Their larvae either feed directly on the bacteria or acting as predators feeding on other insect larvae. A key characteristic of this particular microhabitat is that it is dynamic and does not last long. Thus, for populations of saproxylic Diptera, a continuous input of fresh fallen or dead wood is required.

A particular feature of the important saproxylic Diptera associated with Aspen is their geographical distribution. Most of them are confined to just 14 sites in north-eastern Scotland. These sites contain large stands of Aspen, above 4.5 hectares. Although Aspen is widespread in Scotland it is only in the north-east that such large stands exist. The survival of these Diptera may thus be explained. It is only in these large stands that there is enough Aspen to provide a sufficient input of new fallen or deadwood for breeding.

Few of these vital stands are protected and some have sustained damage in the past few years. One particular problem is grazing by rabbits and deer which often remove the bark of fallen wood thus ruining the breeding site. Another problem is competition from faster growing conifers and removal of fallen wood by people. An additional potential threat is the plan to release beaver into Scotland with their preference for eating Aspen (Batty – this volume).

Measures are required to protect these core Aspen stands if this rich community of saproxylic Diptera is to be conserved. In the short-term, continual inputs of wood can be created by felling one or two trees per year. Aspen stands are often characterised by wind-blown trees lying on their sides, but still alive attached by their root plate. Trees such as these are perhaps good candidates for felling to provide an increase in breeding potential. Over the long-term, Aspen stands can be protected from grazing with fencing as has been started at the Royal Society for the Protection of Birds (RSPB) Reserve at Invertromie (Prescott, this volume). Such protection should enable the fast-growing Aspen to recover and offers the potential to extend Aspen stands and link them up to create a fully functioning ecological unit, C McGowan, this volume).

This is all the more urgent, given recent assessments of the abundance of Aspen dependent saproxylic Diptera. These reveal them to be at a low point in numbers due to the lack of suitable fallen wood in many stands.

Some may argue, why bother to conserve insects such as these flies in the first place? It should be understood that just because these organisms are flies does not mean they lack significance. Scottish Aspen is unique for the richness of its associated saproxylic flies. Many are rare in not only a British but also a European context. Some are accorded the highest level of threat within the RDB and one is a UK Biodiveristy Action Plan Priority species. If such a wealth of uniqueness and rarity is not worth saving, what is? However, there is another aspect to the saproxylic Diptera associated with Aspen that is important. When Aspen spread north following the retreat of the ice about 10-11,000 years ago, many insects that depended on it also moved north. Some of these have separated from populations of the same species further south to varying degrees. Some vary just in ecology, like the hoverfly *Brachyopa pilosa*. In southern Britain, this species breeds in association with Oak, Beech and Poplar, but in Scotland it appears to be restricted to Aspen. It seems that this species has undergone a change in Scotland and is therefore special and adds to the biodiversity of the British Isles. Other insects appear to have gone one further step and speciated with the new species becoming dependent on Aspen. For example, we discovered a new species of scatopsid (small black flies) confined to Aspen, *Ectaetia christii*. This new species is very similar to a widespread southern species, *Ectaetia clavipes* to which it is most closely related (Rotheray and Horsfield 1997). All of these features make Scottish Aspen and its saproxylic Diptera special and important to European natural history. This deserves to be recognised as such and treated accordingly.

Acknowledgements

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The Large Poplar Longhorn Beetle *Saperda carcharius* in the Scottish Highlands

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The Large Poplar longhorn beetle *Saperda carcharius* (Linnaeus) (Cerambycidae), is classified as a notable A species considered to occur in 30 or fewer 10km Grid Squares of the National Grid (Hyman and Parsons, 1992). In the Scottish Highlands, the known distribution of this species has recently been extended from four to 13 10km squares (MacGowan and Begg *In Prep.*).

Larvae of *Saperda carcharius* are found in trunks of Aspen (*Populus tremula)* the preferred larval tree, but other Poplar species, *Salix* and occasionally *Quercus* may be utilised (Uhthoff-Kaufmann, 1991).

Saperda probably spends 2-4 years as a larva within an aspen tree (Hyman and Parson, 1992), after which the adults emerge during July and August. Adults may be found until October. During the emergence period, frass and wood fibres are ejected through a circular hole in the bark formed by an enlargement of the oviposition site. This makes it possible to determine where larvae are present and adults have emerged.

Studies conducted at two sites, Invertromie in Strathspey and a site in Deeside during the emergence period in 2000, revealed that where trees had emergence holes, or showed signs of larval activity, the tree circumference (measured at chest height) was within the range 13-187cm. The mean circumference was 47.4cm.

The circumference of over 200 Aspen trees across the Scottish Highlands was measured and showed that the mean circumference for aspen overall lies in the 81-90cm circumference size range. This demonstrates that *Saperda carcharius* is selecting for smaller trees.

Within each aspen stand, most activity was found to be on trees at the edge of the stand, next to open ground with only a few sites being found within dense cover. Trees found bordering walls, fences or along road verges commonly had an abundance of emergence holes, possibly due to the open aspect consistent with these sites.

Where conditions are favourable and grazing pressure is low, Aspen regenerates by producing suckers from the parent tree, giving rise to dense stands of young trees. These trees are used by *Saperda* larvae. Although larval activity does not directly kill the host tree, it no doubt weakens it by allowing the entry of damaging tree diseases, fungal attack and by weakening the stem, making it more susceptible to wind blow and other damage.

The thinning of Aspen stands to produce relatively open stands of larger trees is, in general, a benefit to the other insects and lichens associated with Aspen. By being an agent in the thinning process, *Saperda carcharius* acts in an ecologically beneficial manner and plays an important role in the ecology of Aspen stands.

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Byctiscus populi, a leaf rolling weevil dependent on Aspen

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Introduction

Byctiscus populi (Coleoptera: Attelabidae) is an attractive, metallic green or coppery coloured leaf-rolling weevil associated with Aspen *Populus tremula* and occasionally Poplars. Fowler (1891) stated that *B. populi* was found 'on young Aspens', and Morris (1999) refers to 'anecdotal evidence that these weevils prefer young growth of suckering and regenerating trees to large, mature individuals'. The UK range of *B. populi* appears to have declined in the past few decades. It is classified as Red Data Book 3 'rare' and UK Biodiversity Action Plan (BAP) - Priority listed species (Morris, 1999). In accordance with recommendations in the UK Species Action Plan, research was initiated in 2001 at the University of Leeds, the designated Lead Partner for this species. Former and extant sites are being resurveyed to update records, and thereby establish a picture of the species' current status. Since ecological knowledge of *B. populi* is largely anecdotal, priority is being given to field and laboratory-based research to examine aspects of its biology and habitat requirements. These findings will be used to advise on practical management actions to aid recovery of *B. populi*. Here we discuss the current UK distribution of *B. populi,* describe some initial findings regarding its biology and habitat requirements and suggest possible causes for its decline.

Ecology

Field studies were carried out during summer 2001 at Monkwood (just north of Worcester, Worcestershire), which supports a strong population of *B. populi*. Comparative studies were also carried out by Lianne Evans (University of Leeds) and Dmitry Telnovs in Latvia, where *B. populi* is still common.

Besides Aspen, *B. populi* is said to be associated with White poplar (*Populus alba*) and Black poplar (*Populus nigra*) (Hyman and Parsons, 1992). However, in the UK and Latvia it appears to occur almost exclusively on Aspen. Field observations and captive rearing of Latvian and UK specimens have provided a reasonably complete picture of its lifecycle.

Emergence of adults, mating and oviposition

The adult insects appear from May onwards, when they can be seen feeding on the leaves of Aspen. Mated females lay batches of between one to four eggs in cigar-like rolls formed from one, or occasionally two, Aspen leaves, with more eggs deposited in longer leaves (Evans, 2001). The larger, longer leaves found at the growing tips of Aspen suckers are the favoured oviposition sites, with plants as short as 30cm utilized. Trees above two or three metres are used more rarely than smaller individuals. As many as four individuals, both females and more rarely males, may cooperate in the rolling of a single leaf roll. This suggests that some rolls may contain the eggs of more than one female. The rolls are sometimes detached almost immediately, or may remain on the trees for several weeks.

From egg to larvae

Eggs of captive-reared Latvian beetles took an average of just under four days to hatch. The first instar larvae then proceeded to feed on the wilted leaf roll from within. Usually at this point the leaf was still attached to the food-plant. The number of larval instars remains undetermined, but mature larva of 4-6mm in length, vacated the roll after an average of around 16 days. It is possible that larvae occasionally complete their development while the roll is still attached to the tree.

Prepupa, pupation and emergence

In common with *B. populi's* slightly larger sister species *B. betulae,* larvae were found to pupate in pupal chambers in the soil at a depth of between 5–60mm. A prepupal stage lasts up to four weeks, followed by a comparatively short pupation, lasting less than a week in some cases. Whereas *B. betulae* overwinter as adults in the pupal chamber (Bily, 1990), captive-reared *B. populi* specimens emerged above the soil surface and began feeding shortly after.

Number of broods and hibernation of the adults

In Monkwood, *B. populi* adults were observed rolling leaves throughout the summer between May and the beginning of August, when suckers were still seen to be producing fresh leaves. The peak activity was around the end of June, when both beetles and leaf rolls were very numerous. It is likely that the beetle is bivoltine or even continuously brooded through the summer. Captive-reared beetles provided with a choice of rough pieces of bark and soil in outdoor conditions in late October 2001, settled beneath the soil and within cracks in the bark and appeared to enter diapause. Whether any final generation adults overwinter as adults in their pupal cells, as described for *B. betulae,* is unknown.

Distribution

Internationally, *B. populi* occurs over the whole of the Palaearctic region, being fairly common in central Europe (Harde, 1998). In the UK, Morris (1999) stated '*There are post-1970 records from east Sussex and east Kent, but historically it was more widely distributed, being recorded from much of southern England northwards to east Norfolk, east Gloucestershire and Worcestershire*'. Now considered to be 'rare' and declining, it is clear from Fowler's (1891) summary: '*very local, but not uncommon where it occurs*', that *B. populi* was patchily distributed even at the end of the 19th century.

A meeting on the conservation of UK BAP phytophagous beetles, funded by English Nature, was held in London in February 2001. It became evident that *B. populi* has continued to decline, having probably become extinct at two of the seven sites for which post 1980 records were available. Ian Menzies, who had regularly recorded the species at Bookham Common Special Site of Scientific Interest (SSSI), Surrey, noted that he had recorded no further specimens since 1991. Similarly, four miles away at Wisely Common, Peter Hodge reported the beetle's recent demise as a result of extensive clearance of pioneer Aspen scrub, removed for conservation purposes!

Four possible post-1990 *B. populi* site records are available, two of which are based on our surveys this year. The first is Oversley Wood, a Forestry Commission site in Warwickshire. Here the most recent of several records since 1987 was made by Lane & Forsythe in May 1999 (Lane & Forsythe, 1999). They beat a single specimen from Aspen and described the Oversley population as 'small and vulnerable'. Aspen is one of the dominant species in sections of this site and our 2001 site visits found several leaf rolls on ride-edge aspen suckers, though no adults were seen. This suggests the population is still extant at Oversley, but remains very small.

The second recent *B. populi* site record was added by Darren Mann (*pers. comm*.), who found the beetle at Wappenbury Wood (a Warwickshire Wildlife Trust Reserve approximately 30km from Oversley Wood) during the 1990s. Aspen suckers proliferate along rides at Wappenbury, though conservation efforts have apparently reduced their abundance in recent years. Leaf scars consistent with *B. populi* were found during our 2001 site visit, but we failed to confirm the continued presence of the beetle.

Orlestone Forest, a Kent Wildlife Trust-managed ancient woodland, near Ham Street was visited in mid-August 2001. *B. populi* had last been recorded at the site in 1972, with records dating back to the mid-1960s. No adult beetles were found, but two leaf rolls, almost certainly created by *B. populi*, were discovered in a sunny, ride edge location. Interestingly, the habitat at this site was very similar, in terms of vegetative composition, structure and management, to Monkwood, another site where the beetle survives.

Morris (1990) has described Worcestershire as a '*blank spot*' because of the apparent under-recording of Coleoptera there. We investigated two woods in the county where there were old (1950s) records for *B. populi*, one of which was Monkwood, where we found what may be currently the strongest UK population of this species. This wood is a Worcester Wildlife Trust Reserve and SSSI. An ancient coppice woodland, and once a 'Harris brush wood', it is now managed jointly by the Worcester Wildlife Trust and Butterfly Conservation. Leaf rolls were noticed even before the site was entered, on low aspen suckers at the woodland boundary adjacent to the road. Subsequent searches within the wood revealed a number of discrete patches of Aspen sucker growth along ride edges and in areas of recently-coppiced Hazel (*Corylus avellana). B. populi* adults and leaf rolls were found in reasonable numbers on virtually all the patches of pioneer, ride-edge Aspen throughout the site. In contrast, the beetle and its rolls seemed largely absent from mature trees (although rolls sometimes occurred on the lower branches of standards in sunny conditions). More tellingly, where aspen suckers occurred as an understorey in areas heavily shaded by mature trees, *B. populi* was almost always absent.

The second site in Worcestershire, which has recently been acquired by Worcester Wildlife Trust, was Randen Wood, between Bromsgrove and Kidderminster, where the beetle appears to have been lost. Aspen was present in this wood in small isolated patches, but the woodland canopy was closed, allowing little light to penetrate. There was no sign of recent management and no evidence that *B. populi* was present.

The contrasting fortune of the beetle at the two Worcester sites and its distribution within Monkwood and elsewhere provides strong indications of the habitat needs of *B. populi* and the management required for it to persist. Small Aspens, growing in sunny, sheltered conditions are what this species requires. The Dark-bordered beauty (*Epione vespertaria*) appears to have very similar habitat requirements to *B. populi*. This moth is known mainly from Aspen sites in Scotland, and it would be well worth looking for *B. populi* at these sites, even though it has not been recorded previously north of the border. Suitable small Aspens are typically found along woodland rides at the English sites, but in Latvia they are also a common feature of roadside verges, derelict land, footpaths and other habitats, hence the beetles much greater abundance there. Perversely, maintenance of open rides is important for the persistence of this species, but thorough ride clearance that results in the elimination of Aspen suckers and bushes deprives it of suitable host plants.

Acknowledgements

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The importance of Aspen for Lepidoptera

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Introduction

The species of Lepidoptera that use Aspen as a larval foodplant are summarised by Emmet (1991), who lists all British Lepidoptera and their life histories. Depending on interpretation of the use made of Aspen by generalist feeders, there are around 40 moth species regularly found on the tree in UK overall, about 25 in Scotland and, of these, 26 are specialised Aspen feeders in UK, whereas only about 14 are mainly confined to Aspen in Scotland (Table 1). Southwood (1961) originally counted the number of herbivorous insects on British tree species, (although this analysis has been upgraded recently for Lepidoptera by Young (1997)). By this reckoning, Aspen harbours a rather modest total, compared with Oak, Birch and Sallow, for example. However, the number found on different trees is positively correlated with the abundance and distribution of each tree and, although Aspen is widespread, it does not compare with other forest trees in its abundance, nor in the tendency to form extensive woodland. Its 'apparency' to moths is relatively low. In Scotland, every large stand of Aspen tends to have a regular attendance of 10-12 moth species, which form a distinct assemblage.

Table 1. Species of Lepidoptera associated with Aspen in Scotland, including only species feeding mainly or exclusively on Aspen.

(Data from Emmet, 1991).

A. Number of species regularly feeding on Aspen	in UK 40 species in Scotland 25 species
Number of species specialising on Aspen	in UK 26 species in Scotland 14 species
B. Species feeding mainly or exclusively on Aspen in Scotland	
Ectoedemia argyropeza (Zell.)	larvae mine in petiole & leaf
Stigmella assimilella (Zell.)	larvae mine in leaf
[*Paraleucoptera sinuella* (Reutti)	larvae mine in leaf (? extinct)]
Anacampsis populella (Cl.)	larvae in folded/rolled leaves
Ancylis laetana (Fabr.)	larvae in folded leaf
Epinotia cinereana Haw	larvae in folded/spun leaves
E. maculana (Fabr.)	larvae in spun leaves
[*Gypsonoma nitidulana* (L. & Z.)	larvae in spun leaves (extinct?)]
G. sociana (Haw.)	larvae in spun leaves
Tethea or (D. & S.) (Poplar Lutestring)	larvae in flat-spun leaves
Lobophora halterata (Hufn.) (Seraphim)	larvae free on leaves
Epione vespertaria (Linn.) (Dark-bordered Beauty)	larvae free on young regrowth
Pheosia tremula (Cl.) (Sallow Prominent)	larvae free on leaves
Clostera curtula (Linn.) (Chocolate Tip)	larvae in spun leaves
Orthosia populeti (Fabr.) (Lead-coloured Drab)	larvae on catkins then leaves
Acronicta megacephala (D. & S.) (Poplar Grey)	larvae in spun leaves

Characteristic species on Aspen

Since Aspen is closely related to other Poplars, and reasonably closely related to *Salix* spp., it is not unexpected to find that it shares a number of species with them. The Pale prominent (*Pterostoma palpina*) and the Poplar hawk (*Laothoe populi*) are examples of species which will readily use most Sallow and Poplars species, whereas the Swallow prominent (*Pheosia tremula*) and the Poplar grey (*Acronicta megacephala*) are restricted to Poplars. However, the latter illustrates an interesting feature in that it is apparently restricted to Aspen and does not use other Poplars in the north of its UK range. This extra specialisation applies to several species. Finally there are some species, such as the Seraphim (*Lobophora halterata*) and the Lead-coloured drab (*Orthosia populeti*), that are always restricted to Aspen.

Most tree species have some moth larvae that feed on the bark, flowers or that bore into the twigs. However, all Aspen's specialised feeders use only the leaves, except that the Lead-coloured drab also feeds on the flowers at first. It is traditionally believed that the flat petiole, leading to the trembling of the leaves, makes it difficult for insect herbivores to remain attached to Aspen leaves, and it may not be coincidence that most species live between spun or folded leaves. For example, the Poplar lutestring (*Tethea or*) uses a series of strong silk pads to attach one leaf on top of another and *Ancylis laetana* makes a neat chamber of a folded leaf.

Even small stands of Aspen will harbour the commoner species of moth, especially those that will also use Sallow or other Poplars. However, it is only Aspen woodlands of a significant size that include the rarer, specialist species. The Chocolate-tip (*Clostera curtula*) is found locally only in the larger Aspen woods. No-one knows how large such a woodland needs to be for this species to survive, but it is clear that it is associated with mature trees, as is the Lead-coloured drab. As will become clear below, other species require regenerating growth and so there is a clear conservation need for large stands of Aspen that include both mature and regenerating stems. The majority of the species that live on Aspen can apparently survive in rather generalised woodlands, but the rare species described below clearly need very much more specialised conditions.

The Dark-bordered beauty and its conservation

The Dark-bordered beauty (*Epione vespertaria*) has always been a rare species but is now very localised indeed and, by nature of this localisation, must be considered threatened in UK. Its English and southern Scottish localities are already published in the literature and so can be safely repeated here, whereas its northern Scottish localities are referred to by a generalised name (Table 2).

At Strenshall Common, Yorkshire and Newnham Bog, Northumberland Dark-bordered beauty larvae are known to feed exclusively on Creeping willow (*Salix repens*) and they have been confirmed recently from these sites, but not from the small handful of other historic English sites. At Adderstonlee Moss, Roxburgh it is also assumed that *S. repens* is the foodplant, in the absence of Aspen, but no larvae have been found to confirm this. Nor has the adult moth been seen there recently, but it must be admitted that the few recent searches have been in less than ideal conditions (K.P. Bland, D.A. Barbour, *pers. comm*.).

Table 2. Sites for the Dark-bordered beauty (*Epione vespertaria*) in UK since 1990.
(Editor's note: excludes details of newly discovered Deeside site)

1. **Strenshall Common, Yorkshire**
   Larvae recently found on *Salix repens*.
2. **Newham Bog, Northumberland**
   Larvae recently found on *Salix repens*.
3. **Adderstonlee Moss, Roxburgh**
   No recent sightings, larvae presumed to feed on *Salix repens*. (No Aspen present).
4. **Near Balmoral, Aberdeenshire**
   Larvae recently found exclusively on low regrowth of Aspen. Adults also seen.
5. **Near Grantown, Strathspey**
   Adults recently found. Larvae presumed to feed on low regrowth of Aspen.
(No *Salix repens* present).

In contrast, at the ‘Balmoral’ and ‘Grantown’ sites, the larvae feed exclusively on Aspen (Leverton *et al.*, 1997) and are confined to regenerating shoots. There is no clear height above which such growth becomes unsuitable, but recently larvae were found on shoots of less than 50cm height and at the ‘Balmoral’ site the moths are seen only where there is abundant suckering of less than 1m height. At ‘Balmoral’, this regrowth has been favoured by irregular cutting of a roadside verge and by the recent clearance of mature woodland to create a pylon wayleave. At ‘Grantown’, intermittent grazing seems to have allowed regrowth, although the number of available shoots is very low there and only a small number of moths have been found. The colony seems to be in serious danger.

Visits have been made to several possible sites, near those on Deeside and Speyside, but so far with only limited success. In summer 2001, a new site on Deeside was discovered, taking the total to three sites in the Cairngorms. Suitable regeneration of Aspen does occur in places near the known sites and there is no convincing reason why these should not be used. However, a successful site will have to have had a continuity of regrowth always available and the adult females are rather sluggish, so that colonisation may only be possible over short distances.

The clear conservation priority is to secure management of the existing sites, so as to maintain and extend the availability of suitably low growing shoots; and then, secondly, to consider the suitability and security of other nearby sites, with a view to possible introductions.

Species in need of relocation

Finally, there are two species that used to be found on Aspen in Strathspey but are now apparently extinct. Urgent survey work is needed to relocate these, or to confirm their absence. *Gypsonoma nitidulana* was found until 1911 on old Aspens near Aviemore but has not been seen in Britain since then. Its relocation may seem to be a hopeless cause but there are ample examples of other species that have been rediscovered after such an interlude such as *Ethmia pyrausta*, recently re-recorded after over 100 years (Smith and Young, 1997). *G. nitidulana* is rather nondescript and its relocation will require collection of larvae by a specialist.

Paraleucoptera sinuella, by contrast, should be reasonably easily recorded, for its larvae make rather characteristic leaf blotches. It was recorded by Bankes, a well-known and reliable lepidopterist, in an Aspen spinney near Aviemore Railway Station in 1910 and it survived there until the 1950s, since when it has inexplicably vanished. It was also found in 1945 near Grantown, indicating that it was not wholly restricted to one site. Abroad, it ranges from Europe to Japan and is often rather common on other Poplars and *Salix* spp., as well as Aspen. The adult is generally found in June and again in August, and the larvae in July and September but there may be only one generation per year in Scotland. Adults are tiny white moths, with minute gold streaks on the wings, but the larvae form oval blotch mines on the leaves. These are 1-1.5 cm long and 0.5-0.8 cm wide when fully formed and are at first brown but then later black. The larval droppings (the ‘frass’) are placed at the centre of the mine, often in a spiral array of fine grains, leaving clear margins to the mine. However, old mines go black and indistinct as the leaves decay. Furthermore, there are other insects that also mine Aspen leaves and so confuse matters. Once the larvae are fully fed, they emerge from the mine and spin a small and sparse rectangular white silk web on a leaf within which they form a dense yellowy-white cocoon, in which to pupate. No other insects form such a spinning and its presence is diagnostic for this species. There is a real hope that *P. sinuella* will be refound in Strathspey in future, by searching for its mines and cocoons.

Conclusions

Conservation of Aspen feeding Lepidoptera requires a general effort to provide a continuity of all ages of tree, in sufficiently large stands to provide for the larger, specialist species. The Dark-bordered beauty has more specialised and exacting requirements, however, and its three remaining sites in northern Scotland will need careful management, to sustain the continuity of regenerating growth. It has survived by accident so far, but we must now act deliberately to secure its future.

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Beavers: Aspen heaven or hell?

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The paper will provide a background to the ecology of European beavers, discuss their potential impact on woodland in general and on Aspen in Scotland in particular.

European beaver

The European beaver, *Castor fiber,* is Europe's largest rodent (average weight c 25kg), and is a separate species from the North American beaver *Castor canadensis*. It has a semi-aquatic lifestyle, and inhabits freshwater, either slow-running rivers or lochs. They generally use water as their main means of travel and are only occasionally found more than c60m from water.

Beavers are social animals and live in family groups consisting of the two parent animals plus the young of the year and sometimes the young of the previous year. The number of animals in a group varies, but an average of 3.8 has been recorded. The group occupy a territory around their lodge, which they defend against other groups. They also use a larger home range, which they might share with other neighbouring groups.

Beavers normally have their young in May-June, and most litters are either two or three young. The young stay with the parents until they are sexually mature and ready to disperse from the home territory, usually at around two years old just before the new young of the year are born. However, the dispersing young may return to the home territory if they fail to find a suitable area elsewhere.

European beavers tend to live in natural holes in banks or excavate burrows with an underwater entrance. Where the banks are not high enough, the Beavers may construct bank lodges consisting of a burrow covered by piles of wood. The lodge contains a vestibule and, typically, one nesting chamber above water level.

Beavers build dams from a variety of materials including wood, mud and sometimes stones. The main reason for dam building is to raise the water level and keep the entrance to their burrow or lodge below the water surface. This reduces the chances of predation and danger to the young. Beavers will also excavate canals to facilitate the transport of material. This can increase their potential feeding range.

Beavers are herbivores, feeding entirely on plant material. They eat an extremely wide range of herbaceous and woody plants, with at least 149 and 80 species recorded respectively. During the late spring and summer they mainly eat herbaceous plants, especially aquatic ones, and take a wide range of grasses, forbs, ferns, shrubs and leaves. The bark and leaves of trees and shrubs forms only a small part of their diet.

Where the preferred herbaceous plants are not available, Beavers will utilise more woody species. This change is most obviously seen in the autumn and winter when woody plants form the vast majority of the diet. Beavers will store branches underwater in the autumn for use in the winter when other food is not available. Trees and shrubs are used for their foliage and their bark, especially in the winter. There is a marked preference for hardwoods, especially Aspen, Birch, Willow, Rowan, Oak, Alder and Ash.

Beavers tend to focus their activities around their burrow or lodge and this influences their foraging behaviour. They travel by water and generally feed up to 100m from the water's edge but most is carried out within 20-60m. Most of their preferred trees and shrubs are harvested near the water's edge. However, observations from Norway indicate that Beavers will travel up to 200m or more to use Aspen, and it is considered that any accessible Aspen within 500m may be at risk of some exploitation. In addition, any Aspen within c 30m of the water would be vulnerable to heavy exploitation. It should be noted that Beavers can only use stands of Aspen that are accessible to them and that they are not as athletic as sheep or deer!

Most trees and shrubs felled are less than 10cm in basal diameter, in Finland the mean being c3cm and in Norway the majority <5 cm. The result is that the vast majority of the hardwoods will then coppice naturally, providing other browsing species are not present, to provide another potential ‘crop’ for the Beavers to harvest in the future. Experience from re-introductions to Brittany and Poland is that the Beavers coppice the woodland rather than clear fell. Although the majority of trees used are small, Beavers are capable of felling trees of greater diameter, up to 1m. Where Beavers have been re-introduced, there has been a range of young regeneration and old mature trees, so the potential situation of just mature Aspen trees has not occurred. Therefore, given Beavers’ predilection for Aspen, it would be advisable to have a range of trees of different ages and sizes in an area.

Re-introduction proposal

The European beaver was once widespread across Europe, including Scotland and the rest of Britain, and northern Asia to Siberia. It probably occurred in Scotland until the early 16th century when it was hunted to extinction for its fur. It suffered a similar decline in Europe until by the 19th century there were only a few populations remaining in Norway, Germany and France. However, through legal protection, translocation and re-introduction it has now been successfully returned to much of its former range.

Scottish Natural Heritage (SNH) is now considering the re-introduction of European beaver to Scotland because:

- It is listed on the EC ‘Habitats Directive’;
- It is recognised as being a ‘keystone species’ in the ecology of woodland and freshwater systems;
- It would benefit biodiversity; and,
- Since humans were responsible for its extinction in Scotland, it has been argued that there is a moral responsibility to redress the loss.

Some years ago, SNH began to examine seriously the possibility of returning European beaver back to Scotland. SNH commissioned work on the suitability of habitats in Scotland to support Beaver and also on the effects of Beavers on hydrology, fish and woodland habitats in Europe. A national consultation was carried out in 1998 to ascertain the views of everyone who might have an interest in the subject. Based on that, SNH decided to go ahead, in principle, with a trial re-introduction which would be in a limited area for a specific period of time. Interest from the Forestry Commission led to an assessment of their holdings in Scotland and Knapdale Forest in Argyll was identified as the most suitable area for a trial. A fully planned trial is proposed with monitoring to determine, amongst other things:

- How the Beavers behave in Scotland;
- Impact on woodland habitat;
- Impact on other wildlife interests; and,
- Impact on water quality.

The trial would last for five years, but if insurmountable problems were encountered during that period the trial would be curtailed prematurely. If the trial proceeds, it is intended that Beavers will be captured in autumn 2002, spend six months in quarantine and then be released in spring 2003. The trial would end in 2008. After the five years, there will be an assessment to help provide information for an informed decision on whether a wider-scale Beaver re-introduction should take place. At this stage there will be wide consultation.

The trial will be taken forward by SNH in partnership with Forest Enterprise, Scottish Wildlife Trust and Argyll and Bute Council.

SNH will make a final decision over the trial in autumn 2002. However, approval will then be needed from the First Minister, as Beavers are not currently part of the native UK fauna and as such a licence is required under the Wildlife and Countryside Act 1981 to release them into the wild.

Potential impact on Aspen

It has already been noted above that Aspen is a favoured food for Beaver and that they will preferentially select it. This could put more pressure on an already restricted resource, both in terms of quantity and quality. However, at present Aspen is under pressure from grazing animals; both domestic (sheep and cattle), and wild (primarily deer, rabbits and hares). A key question is how to reduce or eliminate any extra threat from Beavers?

Direct methods would include the identification of areas of Aspen at high risk from Beavers due to their proximity to water and their accessibility to Beavers. These areas could be easily fenced against Beavers, and, if of high value, might need to be fenced against other animals as well. Relatively low stock-proof fencing should be adequate, avoiding potential significant problems of fence collisions for ‘woodland grouse’. Given that Beavers burrow for other purposes, it would probably be sensible to have an apron of netting on the ground to deter burrowing, especially in soft ground.

If there are concentrations of Aspen along particular river systems, an alternative method would be not to re-introduce Beavers to that catchment. Beavers usually travel via water and experience from the continent is that it can take some time for Beavers to move from one catchment to another one.

However, perhaps the best method for dealing with a potential threat to Aspen from a Beaver re-introduction is to increase the quantity and quality of the Aspen resource, be it areas of Aspen woodland or Aspen stands in other woodland types. In this way the aim would be to manage existing Aspen and create new Aspen areas such that if/when Beavers arrived there would be sufficient habitat for both the Beaver and Aspen. The proposed trial re-introduction of European beaver to Scotland could be used as the publicity to raise the profile of Aspen with the public, land owners and managers, and also the bodies which could provide the funds for its management and expansion. European beaver could be used as an **Aspen flagship species** to heighten awareness.

If the trial went ahead, it would be 2008/2009 before any decision could be made about any wider re-introduction of European beaver to other parts of Scotland. This provides considerable time to begin the active management and expansion of the Aspen resource in Scotland, and to look at ways of improved funding for this work through, for example, Woodland Grant Scheme and agri-environment schemes. If this work took place, and the decision was made not to proceed with a wider re-introduction, then the net result would still be both a raising of awareness of Aspen and a considerable expansion in the Aspen resource.

The return of European beavers to Scotland might be hell for an individual Aspen, but potentially heaven for the Aspen resource as a whole. It is for people with an interest in Aspen to decide how they want to view Beavers, either as a problem or, more sensibly, as an Aspen opportunity.

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Variation in Aspen in Scotland: genetics and silviculture

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Introduction

European Aspen (*Populus tremula* L.) is a widely distributed tree species in the northern temperate zone with a range stretching from Scandinavia to north Africa and from Britain to Japan. While the species is found throughout Britain, it is commonest in northern Scotland (Worrell, 1995a). However, a tendency to grow in small groves on the edges of woodland, a lack of regular seed production (Ennos *et al*., 2000), plus a palatability to grazing, have meant that the total area of Aspen woodland in Britain is estimated at around 500ha (J. Gilbert FC, *pers. comm.*) and woods of more than 1ha are rare. As a consequence, there have been very few studies of the silviculture and genetics of Aspen in Britain (Worrell 1995 a, b) and knowledge of appropriate management to favour this species is limited. The lack of knowledge is the more unfortunate because the importance of the species for both nature conservation and landscape interests is considerable (see other papers in these Proceedings). The purpose of this paper is to summarise some recent studies which provide useful guidance to those interested in increasing the area of Aspen woodland, either through natural colonisation or through planting.

Propagation of Aspen

The recent upsurge of interest in Aspen partially stemmed from recommendations that it be accepted for planting in the Native Pinewood schemes of the late 1980s (Hollingsworth and Mason, 1991). An average of 9ha of Aspen has been planted per year in Scotland since 1996 under the Woodland Grant Scheme (D. Wright, FC *pers. comm.*). Concern was expressed that the only Aspen material that could be purchased from nurseries in Britain at the time was of non-native origin and probably not well adapted to Scottish conditions (Ennos *et al*., 2000). A small research project was carried out in the late 1980s to look at the possibilities of propagating Aspen by cuttings. This resulted in recommendations to excavate root sections in the field during the dormant season, place them in a heated greenhouse to promote suckering, and root the detached shoots as softwood cuttings in a mist house (Hollingsworth and Mason, 1991). Trials have generally shown high rooting percentages using this method (ie 90-100% rooting under mist) but there has been appreciable clonal variation in the number of shoots m-1 of root, and in growth after rooting (Hollingsworth and Mason, 1993).

Although seed production by Aspen in Scotland is infrequent, there have been two recent reports of successful seed collections in Strathspey (Worrell, 1995b; Worrell *et al*., 1999). In addition, some of the native Aspen material offered by commercial nurseries in Scotland has been through at least one multiplication cycle *in vitro* before being grown on for forest planting (R.S.D. Ogilvy, Christie-Elite *pers. comm.*).

Distribution in Scotland

As a result of increasing confidence in the ability to propagate native Aspen, the next question was where could suitable locations of Aspen be found in Scotland. Discussions resulted in a small Forestry Commission/Scottish Natural Heritage project being established in 1992 with nine objectives (see Table 1). Some of these objectives are discussed in more detail below.

Worrell (1995a) recorded some 500 sites in Scotland where Aspen had been reported in the early 1990s. These locations[1] are plotted in Figure 1 together with a further 100 sites recorded since the original survey; the 40 sites identified by Wilson *et al*. (2000) are included. The results indicate particular concentrations of Aspen in Perthshire, Deeside, Badenoch, Strathspey, Easter Ross and eastern Sutherland, with lesser frequency elsewhere. The recorded distribution was divided into eight zones as shown in Figure 1. This used the boundary between Regions of Provenance 10 and 20 (see Herbert *et al.,* 1999) as the first divider, with subsequent divisions along major watersheds.

Investigations of Scottish Aspen using genetic markers

Once the range of the distribution of Aspen in Scotland had been ascertained, it became possible to undertake genetic analysis to find out more about the population biology and genetic variability of Aspen in Scotland. As indicated earlier in this volume, the reproductive biology of Aspen in Scotland is very different from that of most other native tree species. Flowering of the species is rare, and significant seed set is found at distant and irregular intervals (Worrell 1995a, Worrell *et al.,* 1999). Seed is short lived, and the disturbed and open conditions required for seedling establishment are rarely found. Sexual propagation of the species is presently very problematic. On the other hand, the species has a remarkable ability to persist and spread via root suckers, so that individual genotypes have the potential to be extremely large and long lived. The management of native Aspen woods for conservation requires an understanding of how these special features have affected the level and distribution of genetic variation within Scottish Aspen populations. Two studies using genetic markers were therefore conducted to investigate these topics (Easton 1997).

The objective of the first study was to look at the native Aspen resource in the whole of Scotland and assess its genetic variability relative to that of other tree species within their natural ranges. Three main questions were addressed:

- Has the Scottish population retained genetic variability despite its reduced powers of sexual reproduction?
- How is this genetic variability now distributed among the regions within Scotland?
- Is there any evidence that restriction of sexual reproduction has led to inbreeding within the resource?

The study was based on analysis of enzyme genetic markers. This represents genetic variation that is not affected by natural selection (selectively neutral variation [Ennos *et al.,* 2000]), and is not involved in adaptation. This is important to remember when interpreting the results that were obtained.

Dormant Aspen buds were sampled from a total of 275 individuals across Scotland (Figure 2) and scored for their genotype at eight enzyme loci. Measures of genetic variability at these loci were very similar to those found for other long lived woody perennials, though rather lower than for other *Populus* species (Table 2). Analysis of data coming from the six regional populations in Scotland (Wester Ross, Sutherland, Strathspey, Deeside, Perthshire and Southern Scotland) showed that less than 2% of the genetic marker variation was accounted for by differences between these regions. An unexpected finding, however, was that significantly fewer heterozygous genotype were found than would be expected in an outcrossing dioecious species like Aspen (Inbreeding coefficient within populations FIS = 0.153, $P < 0.001$).

[1] *These locations are held on a database at Forest Research - Contact the senior author for more details.*

These results are consistent with postglacial invasion of Scottish Aspen under conditions where sexual reproduction was widespread and seed dispersal and establishment were unrestricted. It appears that this initial genetic structure and variability has been largely retained despite fragmentation and reduction of sexual reproduction as a consequence of vegetative persistence over long periods of time. During this period, limited sexual reproduction of the species has taken place among an increasingly related group of individuals, leading to a significant level of inbreeding in the population as a whole.

Having obtained a broad picture of genetic variation in Scottish Aspen, a second study was conducted to determine the extent and pattern of clonal diversity within native Aspen woodlands. The questions of interest were whether woodlands comprise single or multiple clones, and, if multiple clones are found, do they differ from one another in ecologically significant ways. The study was conducted in Tomnagowan wood, Strathspey, the largest Aspen dominated woodland in Scotland. Within a 7ha sample area, 198 stems of Aspen were mapped and scored for their genotype at seven variable enzyme genetic markers. Stems were also scored for the extent of leaf flushing in June (Figure 3), and for their sex in spring of 1996, an exceptionally prolific year for Aspen flowering (Easton 1997).

Within the sample area, 21 different clones could be identified. These ranged in size from single stems to individuals spreading over 100m. The clones identified in this manner showed very different leaf flushing scores. Individuals within each of the putative clones were all of the same sex and the sex ratio was 3.33:1 male:female, significantly greater than the 1.5:1 ratio normally found within Scotland. These data indicate that high clonal diversity exists within native Aspen populations, and that clones differ widely in important ecological characteristics. In future conservation programmes aimed at restoring or recreating Aspen woods, this clonal diversity must be included within planting stock.

Studies of natural stands

Matthews (1993) carried out a small study comparing growth rates, ages, site characteristics, and incidence of fungal pathogens on 30 sites in northern Scotland, 15 in Wester Ross and 15 in Badenoch and Strathspey. A total of 226 trees was sampled. The oldest tree was 120 years old; only 2% of trees were more than 100 years old with 36% being 50-100 years, and the remainder less than 50 years. The largest tree in Wester Ross was 19m tall by 91cm dbh compared with 25mx39cm in Badenoch and Strathspey. The best growth was found on clay loam and sandy loam soils and the poorest on sands. The incidence of bacterial canker (*Xanthomonas populi*) was relatively low overall (7%), but increased with age to nearly 20% in trees older than 70 years. Similarly, the incidence of butt and heart rots increased with age with the percentage of infected stems exceeding 50% for trees older than 50 years. Height-age relationships were interpreted to predict potential site indices (i.e. dominant height) at age 50 ranging from 6-18m; the former were more characteristic of exposed sites in Wester Ross and the latter of sheltered, fertile sites in both regions. Assuming that the appropriate yield models (Hamilton and Christie, 1971) are those for sycamore, Ash and Birch rather than those for hybrid Poplars (Worrell, 1995b), then potential yields from natural unmanaged stands in the two regions range from 2-6 m^3 ha-1 yr-1.

Silvicultural performance of Aspen clones

Once satisfactory propagation techniques had been devised for Aspen, and a range of locations had been identified, a further stage was to examine the variation in growth rates and other parameters in comparative trials. Five field trials have been established with this aim in Scotland since 1993. These compared a range of Aspen clones – chosen systematically without selecting for superior phenotypes – with selected hybrid Poplar cultivars and, in some cases, selected clones for an Aspen breeding programme in Sweden (see Table 3). The trials were established using normal forestry methods in deer-fenced enclosures. The results after six years are briefly described below. Analyses are based on standard analysis of variance procedures with survival percentages first transformed to the arc-sine scale.

Bush 30 and Cowal 11

These were both small trials with a limited range of Aspen clones. At Bush, mean survival after six years was over 95% with no significant difference between clones. By contrast at Cowal, survival was only 75% overall, largely because of vole damage; there were significant differences ($p<0.05$) among the Aspen clones for survival with a range of 40-100%. Height growth after six years showed very highly significant ($p<0.001$) differences between the Aspen clones (see Table 4); the best clone at each site originated from Tummel in Perthshire. At the more fertile Bush site, the Aspen clones performed less well than the hybrid poplar standards, but this trend was not significant at the more oceanic site in Argyll.

Moray 43

There were very highly significant differences ($p<0.001$) between clones for height, survival and diameter. Survival here was also affected by vole damage with a mean value of c 70% and a range of 32-100%. However, perhaps of more interest is to examine the difference between zones (Table 5). The highest survivals were found in material from the southern Scottish zones (1 and 2), with best growth from clones of the east-central Scotland zone (3). However, the favourable performance of the latter will have been influenced by the fact that the best clone was from zone 3. This was the same Tummel clone which had grown well in the Bush and Cowal trials. The standards generally grew better at this site than the Aspen clones.

Kilmichael 37

Again, very highly significant differences occurred between clones ($p<0.001$) for survival percentage, height and diameter growth after six years. Survival was higher than at Moray, with a mean of 92%; the standards ranged from 23-57%, while the Swedish Aspen clones all had 100% survival. Comparisons between the different zones are shown in Table 6. The best survival is from zone 8 (northern Scotland) and the poorest is from zone 4 (Argyll). The best height and diameter growth is again in zone 3, but once again the mean figure for this zone is increased by the vigorous growth of the Tummel clone. The surviving standards were taller than the average of the Aspen clones. However, the most vigorous growth was shown by the selected Swedish Aspen clones.

Aberfoyle 9

Data is only available for the first three years after planting, when initial establishment could still be having an effect, so only preliminary results are noted here. Survival was generally 100%, with only five clones showing some losses (20% in each case). There were very highly significant ($p<0.001$) differences in height growth, with the Scottish Aspen ranging from 86-266cm. By contrast, the Swedish clones varied from 287-446cm. The fast growing Tummel clone was not included in this trial.

General

These five trials comprise the first systematic attempt to examine variation in establishment and growth rate in Scottish Aspen. Results are encouraging, since they suggest that good survival can be obtained, except where vole damage is a problem, and average height of 1.5-3.0m can be anticipated within six years, depending upon site quality. The possibility of improving growth rates by selection of superior clones, if timber production is an objective, is indicated by the vigorous growth of the Tummel clone at four of the sites and by the vigour of the selected Swedish material on the two sites where it has been planted. Examination of zonal performances at the Moray and Kilmichael sites does not provide conclusive evidence that local origins of Aspen are necessarily the best adapted.

Conclusions

The results reported in this paper only serve to re-emphasise Worrell's view (1995b) that "*Fundamental questions concerning [Scottish Aspen's] ecology and silviculture remain largely unanswered.*" Over the last decade, progress has been made in two main areas. Firstly, we can be reasonably confident that native Aspen can be reliably propagated by cuttings and that this material will establish well and grow vigorously in the field without special attention. Given that we can also be more optimistic about obtaining seed from native Aspen (Worrell *et al*., 1999), there should therefore be no justification for using plants of non-native origin in native woodland restoration or creation schemes.

The other main area of progress is that we understand more about genetic variation in Scottish Aspen, both at a national level and in terms of the occurrence of clones within particular woodlands. As far as the former is concerned, we now know that there is appreciable genetic marker variability within the Scottish resource, little variation between the main regions of the Scottish population, and a low but significant level of inbreeding. This suggests that Scottish Aspen has been derived postglacially from a single source that was freely sexually reproducing at that time, but has since survived chiefly by vegetative propagation. The study of clonal variability has highlighted the need to use a mixture of clones when seeking to establish any sizeable areas of Aspen woodland. We would suggest a minimum of 10 clones in woods of 0.5-1.0ha, 15 clones in those of 1.0-5.0ha and >20 clones in those greater than 5.0ha. Within such schemes, the clones could be planted randomly (mimicking the situation expected with establishment from seed) or in pure blocks of perhaps 500-1000m^2 to mimic the patterns that are now found after the extensive vegetative spread of individuals in our few large Aspen woods.

Apart from these two areas, our understanding of the silviculture and dynamics of Aspen in Scottish woodlands is still rudimentary. The improved growth of the clone from Tummel indicates that there is improved vigour (i.e. 3.5-5.0m height at six years) in the Scottish population that could be exploited for timber production. This suggests that the growth rates of 6-10m^3 ha-1 yr-1 quoted by Worrell (1995b) for Aspen in Norway on 40-60 year rotations could also be achieved in Scotland. The improved vigour observed with the small group of selected Swedish clones also suggests that there is a real possibility of increasing the productivity of Aspen stands where these are being used for timber. However, more systematic, comprehensive and longer-term trials would be necessary to confirm this potential for improved growth. Such trials could also consider other aspects of adaptive variation, such as salt tolerance of clones growing close to the sea (for use in reclamation schemes), and timing of bud burst and leaf senescence.

A further area of interest is the potential use of Aspen as a species for mixture in stands of non-native conifers. The species' tendency to grow in clumps, its vigorous early height growth and its tolerance to gleyed soils all suggest a potential role in enhancing biodiversity within spruce plantations. However, to date no experiments have been established to ascertain desirable patterns of mixture with non-native conifers.

A further limitation is our ignorance of stand dynamics in existing Aspen woodland. Worrell (1995a) cites MacGowan (1991) as indicating that woods of >4.5ha are desirable to provide a complete range of habitats for specialist Aspen invertebrates. Both Worrell (1995a) and Matthews (1993) suggest that trees over 100-120 years of age are rare and that older trees tend to be at risk from fungal pathogens. Based upon first principles and observations in the field, we propose that sustainable Aspen stands should contain a minimum of three age classes, each in discrete homogeneous cohorts. These would be an area of old trees perhaps 80-120 years of age characterised by abundant deadwood, a younger age range of perhaps 30-50 years which could be exploited selectively for a range of timber products, and a young cohort of perhaps 5-10 years to provide a successor stand. It is this last category which is so often absent in existing Aspen stands as a consequence of inappropriate grazing management.

In summary, we believe that these results give preliminary indications of the methods and potential for developing an expanded Aspen resource in Scotland, both as a component of native woodland and of restructured plantation forests. However, there is a considerable challenge for both researchers and forest managers if this potential is to be realised.

Acknowledgements

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Table 1. Main objectives of the FC/SNH project on Aspen from 1992-1996

Objective	Comment
1. Identify over 200 locations for Aspen in Scotland	Over 600 recorded – see text for details
2. Review literature on Aspen	See Worrell 1995a, b
3. Sex all clones at sites and consider potential for natural regeneration	See Worrell *et al*., 1999 for flowering and seed production
4. Make detailed observations of clones in the field	No systematic measurements other than Matthews (1993)
5. Bring two collections into domestication	About 100 clones maintained at NRS
6. Investigate genetic structure of Scottish Aspen	See Easton (1997) and text
7. Establish managed genepools	No progress
8. Test silvicultural performance of Aspen clones	See text
9. Examine adaptive variation in Aspen	No progress

Table 2. Measures of genetic marker variation in the Scottish Aspen resource based on analysis of eight enzyme loci, and a comparison of these values with those for long lived woody perennials and other *Populus* species (Easton 1997)

Sample	% polymorphic loci	Alleles per locus	Gene diversity
Scottish Aspen	54.5	2.00	0.174
Long lived woody perennials	49.3	1.76	0.148
Other *Populus*	85	2.5	0.295

Table 3. Details of comparative clonal trials of Aspen planted 1993-1997

Year planted	Location	Site details	Treatments	Design
Bush 30 p1993	NRS	Restocking site; surface water gley	10 clones (Perthshire, SE and SW Scotland) + 2 standards	Single plant plots; 10 replications
Cowal 11 p1993	Near Tighnabruaich	New planting; brown earth with gleying	8 clones (as above) + 2 standards	Single plant plots; 10 replications
Moray 43 p1994	Near Elgin	New planting; alluvial soil	44 clones from 8 zones + 3 standards	4 plant plots; 5 replications
Kilmichael 37 p1995	Near Cairnbaan	New planting; brown earth	89 clones from 8 zones + 3 standards + 7 Swedish clones	4 plant plots; 4 replications
Aberfoyle 9 p1997	Cashel, near Rowardennan	New planting; upland brown earth	72 clones from 8 zones + 6 Swedish clones	Single plant plots; 5 replications

Notes:

1. Standards are: *P.X euramericana cv* 'Robusta' (1993-1995)
   P.X interamericana cv 'Beaupre' (1994-1995)
   P. trichocarpa cv 'Fritzi Pauley' (1993-1995)

2. Swedish clones are selected Aspens and Aspen hybrids produced in the Skogforsk programme at Ekebo, southern Sweden

Table 4. Height growth (cm) after six years in the Bush and Cowal experiments

	Mean of Aspen clones	Best clone	Worst clone	Standards	5% LSD
Bush	309.6	500.3	223.5	556.0	48.1
Cowal	173.3	311.7	107.4	179.3	49.9

Table 5. Survival percentage, height growth and diameter at 0.1 m of Scottish Aspen clones and Poplar standards after six years in the Moray experiment

	Zone										
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Signif.**	**Best clone**	**Standards**
Number of clones	7	12	5	2	3	4	3	8	-	-	3
Survival (%)	83	84	79	61	51	64	48	57	***	96	67
Height (cm)	217	224	283	189	147	201	153	177	***	350	325
Diameter @ 0.1 m (mm)	32	31	41	23	18	26	21	24	***	64	59

Note: Comparison of zones carried out using the Wald statistic because of unbalanced data (ie different numbers per zone). Values are 55.2, 82.4, and 60.5 for survival (transformed), height, and diameter respectively with 7 df.

Table 6. Survival percentage, height growth and diameter at breast height (dbh) of Scottish and Swedish Aspen clones and hybrid poplar standards in the Kilmichael experiment

	Zone											
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Signif.**	**Best clones**	**Swedish clone**	**Standards**
Number of clones	10	10	4	9	14	12	14	16	-	-	7	3
Survival (%)	91	96	95	87	94	93	93	97	*	98	100	42
Height (cm)	295	282	371	285	261	290	245	262	***	504	694	369
Dbh (mm)	19	18	27	18	16	18	14	16	***	42	74	28

Note: Analysis of differences between zones as for Table 5. Values for survival (transformed), height and dbh are 15.7, 50.8, and 46.7 respectively; all with 7 df

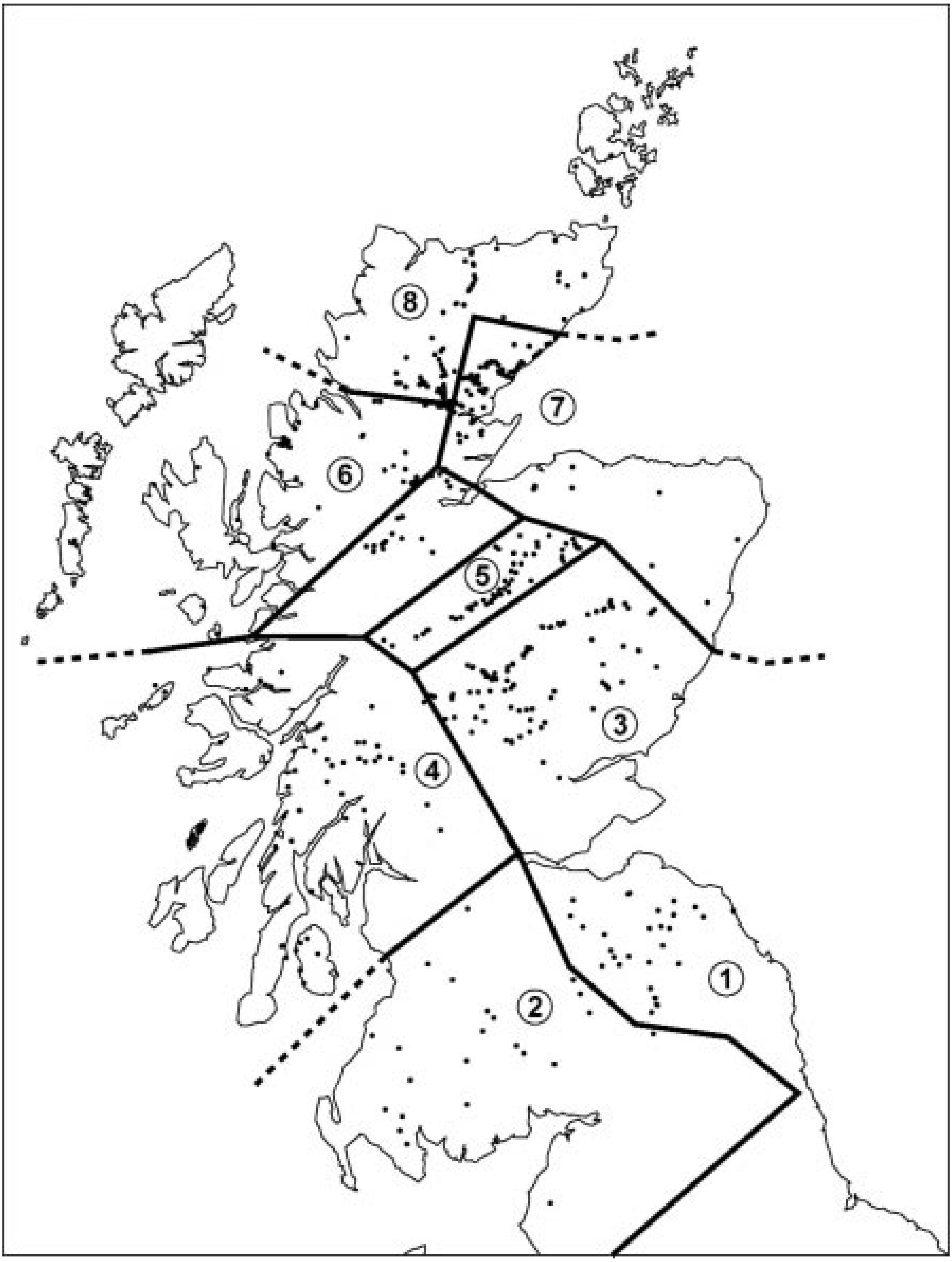

Figure 1. Map showing recorded locations for Aspen in Scotland plus the eight zones into which the distribution was divided.

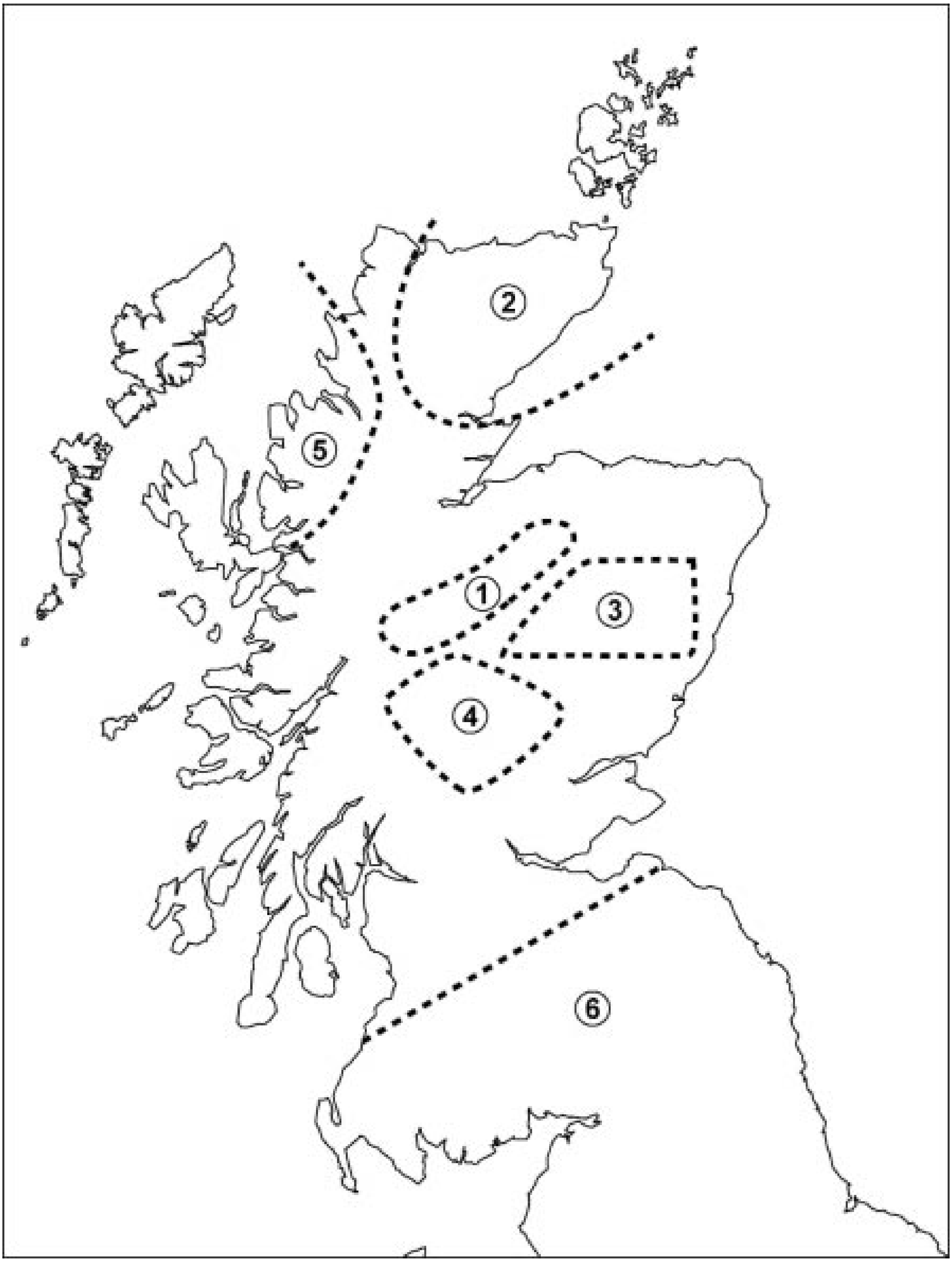

Figure 2. Location of six regional populations of Aspen sampled in the study of genetic marker variation within Scotland. 1 = Badenoch and Strathspey, 2 = Sutherland, 3 = Deeside, 4 = Perthshire, 5 = Wester Ross, 6 = Southern Scotland.

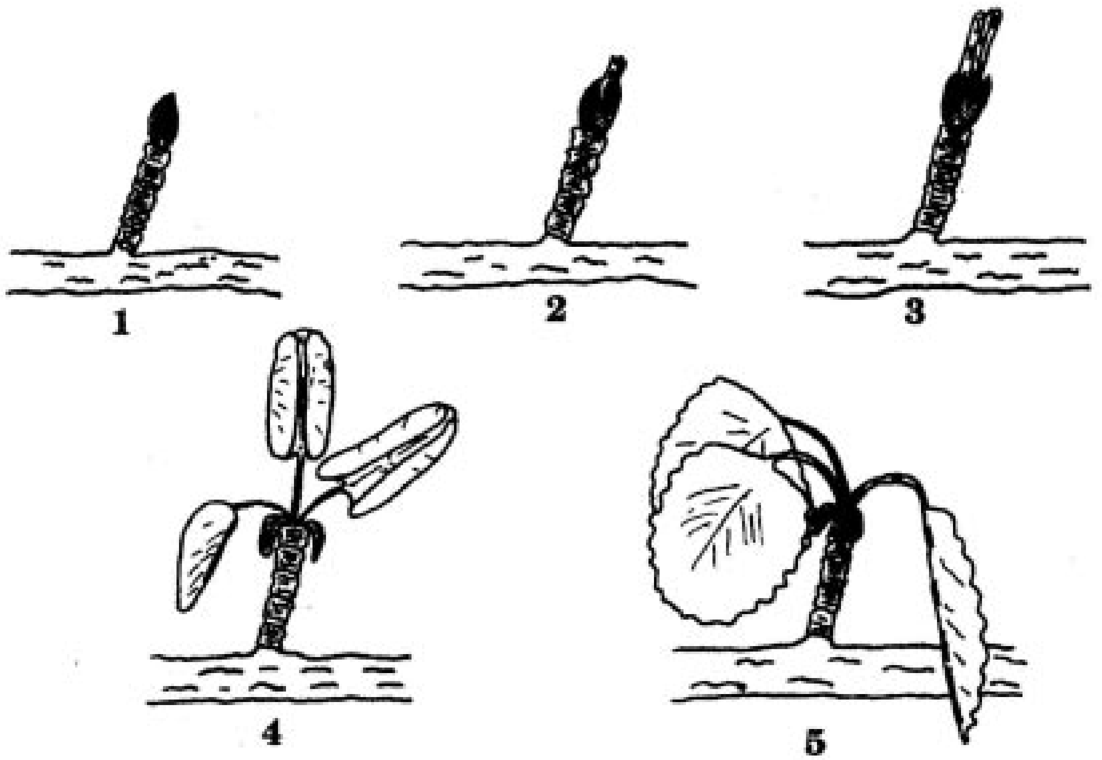

Figure 3. Leaf emergence score for Aspen used at Tomnagowhan wood.

1 These locations are held on a database at Forest Research - Contact the senior author for more details.

Improving the availability of native Aspen for use in northern Scotland

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The opportunity to expand the area of Aspen in Northern Scotland has largely been missed in the extensive native plantings of recent years due to a lack of suitable planting material. The species rarely, if ever, produces viable seed in the north and nurseries have been unwilling to invest in the facilities necessary to produce stock vegetatively. The current nursery catalogues list mainly Dutch and English origin stock, which is not acceptable provenance for Highland use.

Some stock has been produced from restricted seed sources in Perthshire and using micro-propagation techniques from a Strathspey clone. Many of the latter propogules suffer from poor apical dominance, and there appears to be reluctance to buy these in for growing on at £250 per 1000. There is also the problem of no breadth of genetic variability in such stock. As this method only becomes economic with large runs, it is not suitable for smaller scale multiple clone use where 10-20 separate clones are used for plantings up to 5ha.

The best method of improving the availability of northern zone origins would seem to be to produce stock from root cuttings along the lines of Forestry Commission Research Information Note 200 '*Vegetative Propagation of Aspen*'.

There are, however, exceptional costs associated with this method of propagation to enable suitable stocks to be made available at affordable cost to potential users (now frequently plant-for-grant crofters). The particular costs are those associated with root collection and provision of heated mist and wean polytunnel facilities.

Propagation Technique

Aspen roots are located in the field from suckers and lengths are dug up; this is a very laborious process. The root lengths are wrapped to prevent damage, and at the nursery are cut into lengths to fit compost filled boxes. They are laid horizontally and covered with further compost at about 16m root lengths per m^2.

In the spring the roots send up suckers. Surface roots with existing sucker points are the most productive producers of cutting material. When the sucker shoots have reached several centimeters in height, they are cut and transferred to mist and wean beds. Here automated misting keeps the foliage moist and soil warming cables provide a rooting zone temperature of 24°C.

After three-four weeks, the cuttings are sufficiently rooted to allow potting on into cells. They are then kept under mist for a further few days. The collected roots send up a second set of suckers, which are left to grow on to keep the rootstock alive. These are cut the following winter and the process is then repeated in following years. Sucker production varies greatly between clones, but on average a 1m length of root will produce 15 suckers.

Rooting success also shows clonal variation but is typically about 70%. About 40% of potted-on cuttings will produce a plantable 20-40cm one year plant given a reasonable growing season. Forty percent will take two years and 20% will be culled. From these figures, it can be seen that to produce 1,000 plants per annum, about 95m of root stock needs to be collected.

Root Collection

As there is such great clonal variation in suckering and rooting success, it is thought advisable to undertake root collection over a two year period. Limited root collection from a number of clones per zone is undertaken in the first season, and the performance of the clones monitored to determine which stands should have further root collections in the following year.

A collection of 25m root length from each of 10 clones should be sufficient to provide planting stock for an annual planting of about 3ha. Collection costs will vary greatly with site and access etc, but would be in the order of £3/m assuming material could be gathered from two clonal populations in a locality in one day.

Propagation Facilities

It is estimated that each 25m collection would require 4.4m^2 of polytunnel space @ £14/m3. Each collection would require 1.5m^2 of root bed @ £14. Each collection would require 1.0m^2 of heated mist bed @ £30. There would be a fixed cost of £330 for the control units for the mist and wean and heating components. These units would cope with the production from 10 collections.

The total cost per 10 collections is therefore estimated as:

Root collection	£ 750
Propagation facilities	£1390
	£2140

It is estimated that this investment would produce 2,600 Aspen per annum.

For a nursery to recover this cost over a five year period, pay 10% finance charges and seek to make a modest 10% return on capital/available finance employed, it would be necessary to charge £330 per 1,000 more for Aspen than for species raised from seed. **At this price it would be unlikely that Aspen could ever be planted in significant quantities where Woodland Grant Scheme (WGS) funding is required to meet costs.**

Chicken and egg

It would seem that such ‘technical difficulties’ allied to high unit costs, in producing sufficient volumes of stock at reasonable commercial rates, is prohibitive to the reproduction of this valuable species at present (notwithstanding the work of Trees for Life and others in propagating Aspen stock on a small scale for local use). Consequently, it is under-represented in most, if not all, appropriate WGS schemes in the northern Highlands and elsewhere.

In the short term, it is expected that under such proposals sufficient Aspen planting stock could be generated from sources locally to fulfil modest planting requirements over the next three years (7,600 plants from 10 separate clonal populations).

If such clonal collection and propagation could be produced by nurseries over a wider area, sufficient northern Scotland provenance stock could be produced within an *Aspen Bank* for future planting schemes. Once set up, nurseries would be keen to expand the bank to accommodate other clones from wider provenances. If successful, this would do much to expand this valuable habitat in the long term.

Such local initiatives are to be welcomed. However, the start up capital costs are prohibitive to many small regional nurseries, and such a project on a larger scale will require targeted incentives to assure success. Whilst Enterprise companies or European Funding could be accessed by individual nurseries in the Highlands, other sources would need to be found. This raises a number of interesting questions, such as:

- Would an Aspen challenge fund be the way forward or an Inter agency funding partnership?
- Is there scope to offer sufficient incentives through the WGS at present?
- Could the Forestry Commission be persuaded to accept lower stocking densities for Aspen planting, thereby reducing the ‘per hectare’ costs to compare favourably with other planting stock? The ability of Aspen to sucker would ensure fully stocked stands, under favourable conditions, in the future.

Of course, even if such incentives were to be put in place, nurseries still have to produce sufficient stock. Did someone say chicken and egg?

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Woodland management measures for Aspen woodlands

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The purpose of this talk is to identify how the Woodland Grant Scheme (WGS) can assist in improving the extent and condition of Aspen stands and their associated flora and fauna.

The Forestry Commission's WGS was introduced in 1988. It aims to encourage people to create new woodlands and forests to produce timber, improve the landscape, provide new habitats for wildlife, and offer opportunities for recreation and sport. It seeks to encourage good management of forests and woodlands, including their well timed regeneration, particularly looking after the needs of ancient and semi-natural woodlands. Its current form, WGS III, is presently under review and out to public consultation (as of May 2001).

Funding is increasingly targeted at specific priorities and it is in this context that we should look at management incentives for Aspen.

Priorities for Aspen

From the various species accounts and subsequent discussions we can identify two broad strategic priorities for Aspen:

- *Ensure that Aspen stands are minimally isolated by improving the connectivity of sites*. Species which depend on a rare or patch woodland type may remain isolated, even in a fairly complete network of woods. Thus, we need to look for opportunities to increase patch size and reduce isolation.
- *Enhance conditions within stands of Aspen for dependent species*. Increase the size of existing remnants and manage for continuity of structural conditions. For example, create conditions that continue to be capable of supporting the saproxylic fauna, and carry out management to provide a constant supply of suitable fallen timber. This means ensuring that there are suitable areas of differing growth stages of Aspen.

What incentive mechanisms can help achieve this?

In terms of creating new woodland to improve connectivity of broadleaved woodlands, there is a planting grant and the Farm Woodland Premium Scheme. For expanding semi-natural woodland, the preferred method is by natural regeneration. However, where there is no suitable seed source, planting may be appropriate.

The second priority is to improve conditions for associate flora and fauna within stands of Aspen. This can best be achieved by ensuring that there are sufficient patch sizes of broadleaved woodland, component stands, and critically, adequate representations of age classes within these patches and species components to ensure a sustained supply of suitable niches.

It is worth noting that some key woods are already under management regimes to encourage regeneration, under the WGS; for example, Invertromie, Torcroy and Inverton. However, there is still a need to secure regeneration in other key woods and improve links between them, either by creating new woodlands or by restructuring existing ones. In this context, one issue that must be addressed is grazing. Larger stands are components of larger broadleaved woodlands, which are valuable for shelter and grazing. Total livestock exclusion reduces farmers' options and is not always appropriate or even desirable. For example, *Epione vespertaria* absolutely needs Aspen less than 1m in height and the most practical way to achieve this is through grazing. Until these conditions are achieved there are a number of ways to improve conditions and these can also be managed through, and assisted by, the WGS.

Woodland Improvement Grant

The Woodland Improvement Grant (WIG) is a single discretionary payment to encourage a range of work in existing woodlands. It may be paid to undertake work that will enhance the value of woodland for conservation, landscape or recreation.

In the context of Aspen, assistance is available for woodland owners to manage their woods in ways that will implement the forestry aspects of "Biodiversity, the UK Action Plan".

There are five UK BAP species that rely on Aspen:

1. *Epione vespertaria*
2. *Hammerschmidtia ferruginea*
3. *Orthotrichum gymnostomum*
4. *Orthotrichum obtusifolium*
5. *Byctiscus populi*

The WIG can assist with the following operations:

- Preparing and implementing management plans for semi-natural woods;
- Condition Survey;
- Felling to create deadwood/Creating sap runs;
- Protecting deadwood from stripping; and,
- Respacing regeneration to favour Aspen.

Grant will be paid to cover half the net cost of suitable work, up to a limit of £10,000.

For example, at Invertromie the wood was surveyed to assess its deadwood resource, and management operations were prescribed to create a continuity of supply of fallen deadwood as a habitat resource for the Aspen hoverfly *Hammerschmidtia ferruginea*. These operations, if necessary, are easy and relatively cheap to carry out.

- Establish by survey the present availability of suitable fallen timber.
- Do you need to protect it from being stripped?
- Do you need to create more by felling, delimbing, and for how long?
- For the Dark-bordered beauty *Epione vespertaria,* you need to establish regeneration and maintain areas of young regeneration either through grazing or though encouraging areas of regeneration over a longer period. The Dark-bordered beauty is associated with suckering Aspen <1m in height. Appropriate grazing is therefore critical.

Annual Management Grant

Annual Management Grant is an incentive to help towards some of the cost of work that is necessary to maintain and safeguard woodlands. It is a contribution to costs to safeguard or enhance the existing special environmental value of a wood. It provides assistance at a rate of £35 per hectare as a contribution to the costs operations such as:

- Management plans.
- Essential survey work - e.g. archaeological survey.
- Removal of invasive species.
- Control of exotic natural regeneration.
- Uneconomic thinning/felling to encourage natural regeneration.

- Broadleaved planting (up to 300 plants/hectare. Larger plantings should be funded through normal grants).
- Essential monitoring of management effects - e.g. population monitoring.
- Deer and rabbit control: this is not normally eligible but exceptionally a case may be made for (e.g.) developing a coherent management plan where this is clearly essential to enhance the special environmental value of the woods.

Restructuring

Restructuring mainly conifer woodland through Forest Plans

Forest Plans were introduced in 1999. The Forest Plan is aimed at woodland owners who plan to carry out felling, restocking and thinning in their woodlands over a 20-year time period. Grants are available to help with plan preparation. The advantages of such medium term planning are obvious. It is worth noting that the approval of Forest Plans is a competitive process and applications are judged against set criteria, one of which is the delivery of substantial public benefit with a high conservation interest.

When Forest Plans are going through the scoping process, it is worth establishing if there are opportunities in existing plantations to favour current broadleaved stands with an Aspen element, or to identify opportunities in the restructuring which will help to create stands of Aspen with links between broadleaved stands. This is one way of establishing links in the network without planting valuable agricultural ground.

Conclusion

Creating a network of broadleaved woodland with an Aspen component capable of supporting the range of Aspen dependent species is a priority that the WGS can help to deliver. The ways in which you feel it can better contribute to priorities for Aspen and its dependent communities might form part of your response to the consultation on the review of the Woodland Grant Scheme and the Farm Woodland Premium Scheme.

MANAGEMENT OBJECTIVE	OPERATION	RELEVANT GRANT	LEVEL OF ASSISTANCE
Expanding woods – improving connectivity of existing stands	Creating new woodland by planting	Planting Grant	£1350/ha
	Creating new woodland by natural regeneration	Discretionary Payment and Fixed Payment	50% of capital costs plus FP of £525ha.
	Farm Woodland Premium Scheme Payment	£60/ha /15 yrs unimproved land	
Encouraging natural regeneration in existing woods	Encouraging and securing regeneration within woodlands	Discretionary Payment and Fixed Payment	50% of capital costs plus FP of £525ha.
Improve habitat condition for species in the UKBAP	Various	Woodland Improvement Grant (3) for Biodiversity	50% of net cost of eligible work up to £10,000
	e.g. Felling to create deadwood		
	Creating sap runs		
	Protecting deadwood from stripping		
	Respacing regeneration to favour Aspen		
Safeguard or enhance special environmental value	Various	Annual Management Grant	£35/ha/ yr as a contribution to costs
	Management plan /Survey work		
	Uneconomic thinning/ felling to encourage regeneration		
	Enhancement planting (up to 300 trees/ha.)		

Agri-environment management measures for Aspen woodlands

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Background to agri-environment schemes in Scotland

Opportunities for the management of farm woodlands through agri-environment measures have been available in parts of Scotland for more than 10 years. For example, in the Badenoch and Strathspey area under the Cairngorm Straths Environmentally Sensitive Area (ESA) Scheme. The ESA was the first, and until this year, the only agri-environment scheme to address farm woodland management. ESAs were introduced to Scotland in two phases between 1987 and 1994 to 10 designated areas, selected for their conservation importance. The Cairngorms Straths ESA was introduced in 1994 and came to a close (for new applications) at the end of 2000. In these six years, we have seen almost 85% farmer uptake into the scheme, which equates to nearly 300 farm plans.

Under the Habitat Scheme, a short-lived programme introduced in the early 90s to Scotland, targeting limited farm habitats, no woodland management options existed. Similarly, under the Countryside Premium Scheme (CPS), a competitive scheme which ran from 1994-1997, and was available to farmers outwith ESAs, farm woodlands were not addressed, but were encouraged to be managed under Forestry Commission (FC) schemes in all cases.

In 2001 we have seen the arrival of the Rural Stewardship Scheme (RSS), which now replaces all previous schemes (for new applications) across the length of Scotland. The RSS contains some limited measures for farm woodland management, but only where a current FC woodland grant cannot be applied. Like the CPS, the scheme is again competitive amongst farmers, who have to reach a particular points ‘score’ on selected priorities before they can enter. Existing ESAs which are managing woodland well will continue to operate for their full 10-year term, then their owners will be encouraged to apply for RSS.

Management measures and their effectiveness

The ESA has been a very effective way of protecting and enhancing small to medium sized native and semi-natural farm woodlands where an area (usually less than 15ha and often below 5ha) is managed for biodiversity and regeneration.

For an ESA application, a farm is assessed for habitat quality and importance, including an assessment of regeneration, floral diversity, bird life etc. within farm woodlands. Management requirements are then proposed for the general protection and enhancement of the feature and applied under the scheme. This will usually involve restricting the grazing pressure to a level that meets the objectives, installing stock and rabbit fencing where necessary. Stock access will then be controlled for the duration of the plan (five years) introducing limited grazing, (preferably cattle, at no more than 1 stock/ha in the late summer/autumn). One sheep is treated as the equivalent to one cow (in grazing density calculations) since sheep are more selective grazers, and can damage seedlings quickly.

Dead wood must remain in the woodland, and no felling is permitted unless to benefit the regeneration process. In return the farmer receives a management payment of £100/ha/yr plus a ‘tier one’ general incentive/good environmental practice payment of £15/ha/yr (in-bye ground) or £1.50/ha/yr (rough grazing).

The greatest advantage of the ESA was guarantee of acceptance of a plan, provided a well balanced and effective application was made. There are approximately 2,800 participants in ESA schemes across Scotland, covering around 780,000ha. Of the 1,500 participants in the CPS (approx. figure), it is unknown how many were advised to enter into WGS at the same time.

While only a small proportion of the overall agri-environment expenditure is likely to be channelled into woodland management, the combined expenditure under the ESAs and CPS in Scotland has risen from £7.93m in 1997/98 to £13.76m in 1999/2000. More recent figures are as yet unknown; however, this is proving grossly inadequate to offer all farms the opportunity to enter environmental plans where desired. This we know from the poor success rate of CPS annual applications, which has hovered between 30% and 40% due to the limited budget and not the quality of applications.

The new RSS has yet to be fully explored for woodland management potential. It is hoped that this will prove flexible enough to realistically manage farm woodlands, particularly on tenant farms. Similarly, a conservation audit is undertaken to assess existing habitats, and proposals are made to enhance and create a range of habitats and features.

For the wider farm habitats, the RSS offers many improved management options and prescriptions, but generally has greater conditions for a reduced payment. This has been the net effect of the European Rural Development Regulation, which has introduced as standard, both General Environmental Conditions and a Standard of Good Farming Practice within the agri-environment programme. Previously (under ESA) this had been encouraged through the small incentive payment of ‘tier one’.

Grazing is rather more limited under RSS than ESA, with a low-level allowance being given only once every three years, to aid ground conditions for regeneration, (special cases can however be proposed). Additional management requirements include the removal of rhododendron where present, the removal of exotics if threatening to the woodland interest, and the non-removal of dead wood, which includes leaving standing dead wood.

Unfortunately, due to the RSS being competitive across Scotland, applications must qualify with a high-ranking score, where the ‘pass figure’ will be wholly dependent upon the annual number of applications and the Scottish Executive agri-environment budget. This of course gives little guarantee for many valuable habitats, including Aspen woodland to be managed.

Management for Aspen in agri-environment

Often Aspen will be found on farms in small clumps within birch woodland, or indeed as a few isolated trees, and as we know the saplings appear to attract grazing quickly. Having heard the requirements of the many Aspen-related species, it is important that we try to apply the scheme prescription appropriately to the needs of Aspen and these associated species.

For example, limited grazing may be less appropriate in the first stages of Aspen regeneration, where saplings are particularly palatable to stock, but could be an important tool once initial growth has occurred to thin regeneration, or indeed meet the habitat conditions required by, for example, the Dark-bordered beauty moth.

We have also heard that the nationally rare Aspen hoverfly depends on dead wood of a particular age, and often where a limb is dying/dead but is attached to the root plate, this can potentially introduce detrimental fungus to the tree. This is where a variation on the RSS prescription ‘standing dead wood must not be felled’ may be required. Fortunately, agri-environment schemes will permit such variations where particular conservation importance exists.

Conclusion

In conclusion, while FC grants undoubtedly play the greatest role in the management of Scottish woodlands, I believe that small farm woodlands, particularly on tenant farms, still require an avenue to encourage management to improve woodland structures for biodiversity and future shelter, as has been shown through the ESA. This requires compensation for loss of use, and importantly the ability to retain these woods within the agricultural unit.

Agri-environment schemes run for 10 years, with a five-year break clause, thus can be easily accommodated within a tenancy or farming partnership and in the general short to mid-term planning of a farm. This term can also contribute significantly to the longevity and condition of our farm woodlands.

In this first year of RSS applications, I have been delighted to find that in working closely with the FC's Northern Conservancy, we have found a reasonably meaningful understanding where a farm woodland would not be 'appropriate' for WGS. This however needs greater clarifications on a national scale for advisers.

Finally, I hope that for tenant farmers in particular, we will also see the continued inclusion of woodland management within the RSS, and a significantly increased budget in future for the benefit of Aspen and other flora and fauna of all farm woodlands in Scotland.

Delivering action: how Aspen fits into the UK Biodiversity Action Planning process

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A brief history of recent forest biodiversity planning milestones

In 1992, the UK Government signed up to, and later ratified, the Rio Earth Summit's Convention on Biological Diversity. This single act had profound effects upon the UK's forestry industry and how forest biodiversity conservation should be addressed. In 1993 the UK Forestry Minister signed up to the General Guidelines for Sustainable Management of Forests and the General Guidelines for the Conservation of the Biodiversity of European Forests at Helsinki. The 'Helsinki Guidelines' interpreted the Rio Biodiversity and Sustainability principals for European forest management. This was further defined and ratified through the Lisbon Pan-European Ministerial conference on the Protection of Forests in 1998. The 'UK Forest Standard' was published in 1998 and this identified what the UK had signed up to in terms of our international commitments. From this point in time, the UK forestry industry fully embraced the concept of multi-purpose forestry, including biodiversity conservation.

The UK biodiversity planning process

Running in parallel to the biodiversity policy developments in the forestry industry, has been the much broader process of general UK biodiversity planning. Since 1994, the UK Biodiversity Steering Group has published a UK Biodiversity Action Plan (BAP) Strategy and series of action plans for the UK's most declining, threatened and endangered species and habitats. However, this is not a complete list because of a lack of data on some species (especially on degree of decline). Unfortunately, 'Aspen woodland' does not have a UK Habitat Action Plan, unlike for example 'Upland Ash woodland', and neither does it get its own Species Action Plan (SAP), in the same way that Juniper does. Using the conventional UK habitat listing process, 'Aspen woodland' is not considered a habitat in its own right, or even a priority, but it could be considered part of other habitats such as 'Pine woodland', 'Wet woodland' or 'Birch woodland', none of which are particularly appropriate. For example, 'Birch woodland' is currently defined by the UK BAP listing process as 'Oak woodland' without Oak; thus 'Aspen woodland' is probably 'Oak woodland' without Oak and Birch! It might also be considered part of 'Riparian or Wet woodland', but this is equally unsatisfactory as most Aspen stands are not 'wet'.

As described elsewhere, although Aspen is a widely distributed tree in Great Britain, pure woodland stands are extremely rare and confined to the north and east of Scotland. 'Aspen woodland' supports a unique living community containing many rare and scarce species including moths, flies, bryophytes, lichens and fungi that occur nowhere else in the UK. Whilst five of these are listed as '*Priority'* species under UK BAP, requiring the implementation of SAPs dedicated to their survival, many others that should be listed under the UK BAP process are not (for example, several Red Data Book invertebrate species). Ecologically speaking, 'Aspen woodland' on its own or in association with Birch and Scots pine is a real habitat and has its own very distinct flora and fauna, which is not served well by the current UK BAP process.

The Scottish Executive recently produced a policy statement called '*The nature of Scotland*' (2001). The proposals in the document outline the single most important piece of wildlife legislation since the 1981 Wildlife and Countryside Act. Amongst its many recommendations is for *"a new statutory duty for Scottish Ministers* (and competent authorities) *to have special regard to the conservation of biodiversity, the richness and variety of our species and habitats"*. This piece of legislation is very similar to the comparable Countryside and Rights of Way Act 2000 for England and Wales, which sets in legal terms the conserving and enhancement of biodiversity in accordance with our Rio Biodiversity Convention commitments. It provides long overdue statutory backing for the current BAP process in Scotland.

This approach, in a non-statutory form, has already been adopted and adapted by Local Biodiversity Action Plans (LBAPs), with national and local partners coming together to agree delivery of local biodiversity action across Scotland. With the proposed change to statutory powers likely in Scotland, it is worth briefly considering what has happened south of the border, where there has been a statutory duty on English and Welsh competent authorities towards biodiversity conservation.

Opportunities and constraints

Initial indications suggest that anything with a UK action plan - a so-called *Priority habitat* or *species* - potentially attracts interest, resources and action. To stop an avalanche of requests for biodiversity action on everything, many of the statutory agencies/partners appear reluctant to put significant resources into non-priority issues. Theoretically, this is great news for listed *Priority* species and habitats but where does it leave the others? In many ways it is too early to tell from England and Wales, but we should be aware of how the UK BAP listing process might influence what action is possible for Aspen. As someone might have once said "*all habitats and species are equal, but some are more equal than others*".

Therefore, in theory at least, it should be possible to get significant resources and effort committed to the following four (five) UK *Priority* Aspen species without too much difficulty:

- *Epione vespertaria*, the Dark-bordered beauty moth;
- *Hammerschmidtia ferruginea*, the Aspen hoverfly;
- *Byctiscus populi*, a leaf rolling weevil;
- *Orthotrichum obtusifolium*, the Blunt-leaved bristle moss; and,
- (*Orthotrichum gymnostomum*, the extinct (?) Aspen bristle moss).

Luckily the moth requires young, regenerating Aspen, the moss requires mature trees and the hoverfly requires dead wood. Thus, three of the extant Scottish *Priority* species appear to require all the basic successional stages of Aspen woodland. On the face of it, action for these three Scottish Aspen flagship species should bring along much/most of the other Aspen interest. However, all three species have very small and fragmented populations, effectively confined to parts of the Cairngorms. As a result, it is likely to prove difficult to obtain resources to deliver action in areas outwith the immediate vicinity of the localised remnant populations of the three Aspen *Priority* species.

Furthermore, there is a genuine concern that it is relatively difficult to get money/resources spent on single species (even *Priority* species) issues when there is so much *Priority* habitat management that could get the money instead. Much of the excellent past native Pinewood work has been done on the back of *Priority* habitat improvement. The Pinewood *Priority* flagship species, such as Capercaillie *Tetrao urogallus*, help focus interest, but the management of the habitat for a range of species is of greatest biodiversity importance and this has largely driven the successful delivery of the UK HAP for native Pinewood.

In terms of biodiversity, the critical aspect of an Aspen community is the transition from groups of scattered individual trees to a larger more extensive/continuous Aspen stand, which then acts as an ecological entity. It is only these larger stands that can support the full Aspen community, including those which depend upon a regular supply of dead wood and decaying trees for larval development. To really deliver action, and avoid as much duplication of effort and bureaucracy as possible, it is suggested that the key Aspen species experts come together with habitat specialists to develop a hybrid action plan for the Aspen habitat and its dependent species (such as listed in the Cairngorms LBAP). This plan could then be taken forward in an integrated manner by the key partners.

I believe the participants of this seminar are in a unique position to take such a step forward. However, there are four simple questions that need to be answered first before we can move forward, and I would like to ask the seminar's participants to discuss and answer these questions:

- Will action targeted specifically at the three extant Scottish *Priority* Aspen flagship species deliver the goods for the remainder of the Aspen flora and fauna? Or to put another way, is it sensible to concentrate on the three *Priority* species and not the habitat?
- Do we need to collectively make appropriate representations to the UK Government regarding the (non) listing of Aspen woodland under the UK BAP?
- Regardless of the answer above, should one of the key outputs of today's seminar be a national Aspen Action Plan?
- Finally, if you think that the development of an Aspen Action Plan is a good idea, would you be willing to be involved in its development and implementation?

The Trees for Life Aspen Project

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Introduction

Trees for Life initiated an Aspen project in 1991 as part of our work to help restore the Caledonian Forest in Glen Affric and the surrounding areas. Our observations had shown that the species only occurred in small stands, often widely separated from each other, and that little regeneration was taking place because of grazing pressure, primarily by Red deer. In addition, in the light of Aspen's relatively poor ability to reproduce from seed (Worrell 1995a, b), we recognised that, unlike other tree species such as Birch, Rowan etc, it was very unlikely to spread beyond the sites where it was already established. To address these concerns, our Aspen project has four main elements to it:

- Surveying and mapping of existing stands;
- Protection of ramets or suckers at existing stands to facilitate natural regeneration;
- Propagation and planting of young Aspens; and,
- Research into the ecology of Aspen.

Surveying and mapping of existing stands

Commencing in 1991, we began recording data on Aspen stands in Glen Affric, and subsequently expanded this work to other locations, such as Glens Cannich, Strathfarrar and Morriston, where Trees for Life also seeks to restore native forest. The information gathered at each site includes data on: soil types; aspect; elevation; number, height and stem diameter of trees; numbers of ramets observed; evidence of grazing; and associated vegetation and tree species. This information is stored in a database and, to date, 195 Aspen stands have been surveyed in this way, with the mapping continuing on an ongoing basis.

Throughout this work, it has become apparent that Aspen occurs more widely than we had first thought, and 53 Aspen stands have now been identified in Glen Affric alone. The stand sizes vary from some which contain only one tree to others with more than 300, and with heights which range up to over 20m. Some of the most extensive Aspen stands, with the tallest trees, are in riparian areas in Glen Morriston and on the Royal Society for the Protection of Birds (RSPB) Corrimony Nature Reserve. All the data we've collected has now been transferred on to a GIS data set for us by a student from Bangor University, and this will provide a valuable tool for planning the strategic expansion of Aspen in the areas where we work.

The surveys have also produced some interesting data. For example, most of the Aspen stands in Glen Affric are in south-facing rocky locations, whereas, by contrast, the majority of sites we have observed in Strathconon are on north-facing rocky sites. However, rather than indicating preferential growing conditions, it is likely that these observations reflect the topography in each glen, with the sites forming the least accessible parts of Aspen's former distribution, where some trees have been able to survive because of the reduced incidence of grazing there.

Another result of our surveys has been the discovery of an Aspen site in Glen Affric which consists only of young ramets measuring 30cm or less in height, with no evidence of a parent tree anywhere nearby. This is an example of the ability of Aspen's roots to survive underground for many years after the death of the parent tree, with the photosynthesis from the ramets' leaves providing enough nourishment to keep them alive. This phenomenon has been known of since the 19th century (Bπrset 1976; Barring 1988), and in the case of the example in Glen Affric, we suspect that the parent tree(s) may have been drowned when the construction of the Benevean dam in the 1950s raised the level of Loch Benevean by 6m, with the roots and ramets surviving on higher ground.

The surveys have also recorded seasonal phenomena associated with Aspen. In the summer of 1999, for example, we documented widespread blackening and dying back of leaves at various stands in Glen Affric. This was subsequently identified by Dr Adrian Newton and colleagues at Edinburgh University's Institute of Ecology and Resource Management as being caused by *Venturia*, an ascomycetes fungus which non-lethally infects Aspen, particularly in years of stressful conditions such as drought. Flowering of Aspen is known to occur irregularly, and during 10 years of surveying in Glen Affric, we have observed it twice - in 1996, when Aspen flowered profusely throughout Scotland (Worrell *et al.* 1999), and on a single tree in 2001.

Protection of ramets or suckers at existing Aspen stands

The surveys confirmed our casual observations that very little natural regeneration of Aspen was occurring in any of the stands, and the ramets showed clear evidence of grazing damage which was preventing their growth. Many stands had profuse numbers of sprouting ramets, but no young trees whatsoever, thereby indicating that recruitment, and therefore successful regeneration of the stands over time, was being completely inhibited.

Beginning in 1992, therefore, we instigated a programme of protection for ramets at selected sites, using a variety of methods. These include the protection of individual ramets with tree guards, and we've used both solid tubes and open mesh Netlon guards for this, with the latter being preferential. In other locations, small areas containing ramets have been protected with stock fencing, with a typical size of such an exclosure being about 3mx6m. Deer are unlikely to jump into such a small, confined space, and these exclosures are readily erected by groups of volunteers using recycled fencing materials, thereby keeping the costs to a minimum. In some situations, we have also used small areas of deer fencing to protect Aspen stands, or have routed the fence lines for larger exclosures which were planned to achieve regeneration of a variety of tree species to specifically include Aspen stands.

Our intention with this work is to ensure that successful regeneration takes place in as many stands as possible, and also to extend the Aspen stands. In addition, another objective, where stands are located near one another, is to link them up to form larger contiguous areas.

Propagation and planting

In early 1992, we began work on the propagation of Aspen from root cuttings, using methods described by the Forestry Commission (Hollingsworth and Mason 1991). Roots were initially collected from a few sites in Glen Affric, and propagation trials were on a small scale, until the technique had been mastered. Following successful bids for funding from the International Tree Foundation and the Millennium Forest for Scotland Trust, a custom Aspen propagation facility, consisting of a polytunnel containing a mist propagation unit and adjacent cold frames, was established at Plodda Lodge, our field base near Glen Affric. Using this facility, the production of young Aspens has been increased to its current level of between 1,000 and 2,000 plants per year.

Roots are collected from Aspen stands listed in our database, with any given stand being left for several years to recover before further roots are collected. The young Aspens grown from the root cuttings are all tracked with regard to which parent stand they are derived from, and when they are planted out, this is done in groups containing representatives of at least six or seven parent stands. This not only provides genetic diversity within each planted group of Aspens, but also, by statistical averages, should ensure that both male and female plants are represented in each planting. This, in turn, should help to facilitate pollination and seed production when the trees reach reproductive age. To ensure that the local provenance of Aspen is maintained, only young trees grown from parent stands within a particular glen, such as Glen Affric for example, will be used for planting out in that glen.

Planting has been done to both establish new Aspen stands and to enrich the clonal diversity of existing stands, by planting trees sourced from parent stands elsewhere in the same glen. Because Aspen is one of the most palatable trees (Worrell 1995b) for herbivores such as Red deer, all the Aspens we've planted have been protected, either with individual tree guards, or inside fenced exclosures. The planting sites have generally been selected on the basis of exhibiting similar characteristics to the extant stands of Aspen, with the caveat that these conditions may not be the preferential ones for Aspen, but just where the species has been able to survive.

There is an ongoing monitoring programme for the trees we have planted, and results in December 2000 showed that in one area where 66 small Aspens had been planted in 1996, the average height after four years of growth was 95cm, with individual heights ranging from 13-180cm. In another location, one tree planted in 1993 had reached a height of 350cm by December 2000. In future, we intend to refine our monitoring system to track the relative growth rates of Aspens grown from different parent stands, to identify the variation between them.

Research into the ecology of Aspen

With Aspen having been little studied in Scotland until recently, research into the ecology of the species is an important component of our project. In the past few years, several students from Edinburgh University have carried out research into Aspen in Glen Affric for us. Isozyme analysis has been used to 'fingerprint' the different Aspen clones in a number of stands, and a clear relationship was found between the size of the stand and the number of clones it contained. Contrary to the assertions of some authors (Easton, 1998), this research found that the small stands of Aspen studied in Glen Affric generally consisted of more than one clone. Other research has documented the extent of grazing damage by Red deer on ramets, and we've used the results from this to plan and implement protection measures for a number of Aspen stands in Glen Affric.

In recent years, a unique community of saproxylic insects has been identified as being associated with Aspen stands, and specifically with dead Aspen wood (MacGowan 1991; Watt 1998; Rotheray, this volume). The key criteria for the survival of this community are Aspen stands with a minimum area of c 5ha and a regular supply of dead Aspen wood. Although none of the stands we've surveyed achieve the 5ha criterion, we commissioned a survey in May 2001 by members of the Malloch Society to look for evidence of the Aspen-dependent saproxylic insects at selected Aspen stands in Glen Affric and on the RSPB's Corrimony Nature Reserve in upper Glen Urquhart. Although the results of the study were not available at the time of writing, some of the saproxylic insect species, consistent with the size of the stands, were recorded, although the full range of species were not present. However, we anticipate that the study will produce recommendations for management measures to expand and link up nearby stands, so that in time there will be adequate habitat for the whole saproxylic insect community.

During the Malloch Society's study, the rare fungus, *Phellinus tremulae*, which grows on Aspen trees (Emmett & Emmett, this volume) was observed for the first time in Glen Affric. This highlights the need for further research and study to be carried out in the area, and indeed on Aspen throughout much of its range in Scotland.

Current work and future directions

Trees for Life has identified an area of approximately 900 square miles, to the west of Inverness and bounded by the two main roads from Inverness to Kyle of Lochalsh, where we aim to promote the restoration of the Caledonian Forest and all its constituent species. To this end, one of our immediate goals is to complete the surveying and mapping of all the existing Aspen stands in this area. By adding them to our Aspen GIS data set, we will be able to prioritise areas for both regeneration measures and the possible establishment of new Aspen sites.

With the proposed trial reintroduction of European beavers to Knapdale in Argyll during 2002, concerns have been raised about the future of Scotland's Aspen population, as it is a favourite winter food for Beavers (Macdonald *et al.* 1995, Batty this volume). If the trial reintroduction is determined to be successful, more widespread reintroductions may follow later, and Loch Benevean in Glen Affric is a possible candidate site for this. With this perspective, we have begun to focus some of our work with Aspen in Affric more specifically on increasing the extent of Aspen in the area around Loch Benevean. In May and June 2001 we carried out work to establish some new stands on the north shore of the loch, to secure natural regeneration at more of the existing stands and to enhance some of those stands by planting young Aspens in them, sourced from other Aspen stands in the glen.

We plan to expand this programme in the next two years to include the south side of the loch, and our goal is to establish a robust and healthy Aspen population in the vicinity of the loch, which would provide an adequate and sustainable food supply for any Beavers which are reintroduced in future, without it being at risk of over-exploitation.

Similarly, we are also working to incorporate the habitat requirements of the saproxylic insect community and of the Dark-bordered beauty moth (Young, this volume), into our plans for regenerating and expanding Aspen in the areas where we work. We hope to follow up the Malloch Society study in 2001 with other specialist surveys in the near future for the moths, lichens, mosses and fungi associated with Aspen. Drawing all of these elements together, we aim to produce a comprehensive, integrated management plan for Aspen for Glen Affric, and eventually for the other glens where we are working to facilitate natural regeneration of the native forest.

Finally, the other area which we are currently working on is the establishment of a central information resource on Aspen, and our intention is to host this on the Trees for Life site on the World Wide Web, so that it is easily accessible to land managers, researchers and the public alike.

Acknowledgements

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The management of Invertromie Wood, Scotland's fourth largest stand of Aspen

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Introduction

Aspen, (*Populus tremula*), is one of the most widely distributed tree species in the British Isles. It is Scotland's only native Poplar and a characteristic species of the Scottish Highlands, but it is only in Strathspey, Deeside and parts of Sutherland that Aspen dominated woodlands occur. Elsewhere, Aspen tends to be found only in isolated small stands clinging to steep crags and hill-sides in remote Highland glens. Aspen also adds a unique charm to the landscape being one of the last trees to come into leaf in the spring and has very distinctive yellow autumnal colours.

Today only 160ha of Aspen woodland remains, a scarce and very threatened resource, comprising of only 18 stands that are larger than 1ha, of which only 25ha has any statutory protection, (MacGowan 1992). These larger stands are true remnants of the boreal woodland that colonised the Highlands soon after the last ice age. Invertromie Wood on the RSPB Insh Marshes Reserve is one of these stands.

The RSPB and Aspen

The Society's interest in Aspen began in the 1990s when it became lead partner for three UK Biodiversity Action Plan Priority Aspen dependant species:

- ***Epione vespertaria*** (formerly *E. parallelaria)*: The Dark-bordered beauty moth
- ***Orthotrichum obtusifolium***: The Blunt-leaved bristle moss
- ***Hammerschmidtia ferruginea***: The Aspen hoverfly

The niche of these three species is extremely different, each one representing a distinctive stage in the succession of an Aspen woodland. *Epione* requires low scrubby regenerating Aspen, *Orthotricum* only grows on mature trunks, whilst *Hammerschmidtia* likes Aspen dead wood. All three species should be seen as flagship species, each representing a wide range of species across the taxa that similarly depend on Aspen. The future of Aspen conservation in the UK currently lies with these species and this process (Cosgrove, this volume).

Invertromie Wood

The RSPB's Insh Marshes Nature Reserve in the central Highlands is primarily renowned as an internationally important wetland (Prescott 2000). However, it is also gaining recognition for its Aspen dominated woodland at Invertromie, Scotland's fourth largest stand of Aspen. It is around 50ha in size and is predominantly a Birch wood with an extensive Aspen component comprising around 20%. Other species include Hazel, Bird cherry and Rowan.

Invertromie Wood came under RSPB management in 1987 and one of the first steps was to remove the winter sheep grazing. Much of the Birch and Aspen regeneration dates to this time. However, much of the site is overrun with Rabbits, the light sandy soils being ideal for burrowing and the adjacent fields providing excellent feeding. Roe deer are also common and browse the Aspen regularly. Thus, there are few signs of regeneration and the wood is slowly dying on its feet.

Management for *Hammerschmidtia*

One of the key species at Invertromie is *Hammerschmidtia*, the larvae live in the wet decaying cambium layer under the bark of recently dead Aspen feeding on the micro-organisms in this pungent and gooey decaying layer. *Hammerschmidtia* requires a regular input of fresh dead wood for its continued survival, but only Aspen stands greater than 4.5ha have a sufficient resource. In 1999, with the support of Scottish Natural Heritage (SNH), the Malloch Society undertook a full survey of the site for *Hammerschmidtia* (Rotheray 1999). This study estimated the larval population at just 65 individuals, surviving in just two pieces of fallen timber and recommended the following specific management proposals.

Invertromie Wood Management Proposals

Objective: To ensure that the Invertromie Aspen stands continue to support the saproxylic fauna.

Proposals:

1. Ensure that two pieces of suitable timber (>15cm diameter) enter the dead wood system each year. Provide these artificially if this does not occur naturally.
2. Make better use of existing dead wood by:
   - Protecting fallen timber from grazing animals that may strip the bark;
   - Severing root plates from fallen trees to prevent fungal competition; and,
   - Felling windblown trees, snags and dead columns to the ground to reduce desiccation;
3. Encourage and promote actions to increase connectivity between stands.
4. Reduce/exclude grazing to promote natural regeneration.
5. Discourage collecting of saproxylic fauna by entomologists.

The key action is the input of fresh dead wood into the system annually. Ideally such wood should have a diameter greater than 15cm, as the decaying cambium layer is too thin to support *Hammerschmidtia* in thinner timber. This happens naturally by wind-blow, either of whole trees, branches or tops. However, if this is not the case the second option is to sever the root-plates of wind-blown trees that are still alive and/or fell Aspen columns and trees whose tops have blown out. If such timber is left in-situ, fungi slowly attack the live wind-blown trees whilst the standing columns quickly dry out. Felling the timber in contact with the ground slows both the fungal attack and the drying out process, thus making the best use of this scarce resource.

An annual survey at Invertromie is conducted each spring to determine the amount of suitable fresh dead wood that has entered the system naturally and the location of new wind-blown trees and columns. If two pieces of suitable fresh dead wood are found then no further action is required that year. If no suitable fresh dead wood has entered the system naturally then the severing of one or two root-plates and/or felling of columns is required. If both of these are not present, then the final course of action is the felling of live trees. This latter scenario must be seen as a last resort and is only sustainable providing there is sufficient regeneration.

It is often necessary to protect this fresh dead wood from browsers keen to strip-off the bark, thus destroying the larval nurseries. This is easily achieved by stretching rabbit wire over the fallen timber without the expense of erecting a full rabbit fence. Such netting need only be temporary as it probably takes 2-3 years for the fresh dead wood to become suitable for *Hammerschmidtia* and it is then only suitable for a further 2-3 years before the bark cracks and the cambium layer dries out.

The provision of 'new' dead wood is an emergency measure and obviously not sustainable in the long-term without regeneration. So, during the winter of 2000/ 2001, a rabbit control programme was instigated with the erection of around 6km of rabbit fencing and installation of 25 rabbit box traps, funded by the Forestry Commission (FC), through a Woodland Improvement Grant. The box traps have proved to be a very effective way of controlling the Rabbits and comprise of an underground box, beneath a tunnel through the fence, with a treadle floor. When unset, Rabbits have free access via the tunnel through the fence and when set, Rabbits fall into the retaining box through the false floor. The boxes are sited on existing runs between 100-500m apart dependant on the density of Rabbits. The traps are initially set weekly and as the catch reduces the period extended to fortnightly or more. The boxes are always set in the late afternoon and checked first thing the following morning. Regular checking of the fence is also vital to ensure that Rabbits are using the tunnels and not creating their own access points by digging under the fence.

In 2000 a survey, jointly funded by RSPB and SNH, was undertaken by the Malloch Society of all the larger Aspen stands in northern Scotland to determine the size of the UK *Hammerschmidtia* population (Rotheray 2000). This was estimated at just 300 larvae, living in just 12 pieces of suitable dead wood, an extremely low population for an insect. Specific management recommendations were produced for each site.

Management for *Epione* and *Orthotrichum*

Epione larvae feed on low shrubby regenerating Aspen up to around 1m in height. There are currently only three known sites for this moth in Scotland (Young, this volume). The adult moths often fly weakly during the day and are not strongly attracted to light.

RSPB and Butterfly Conservation are currently overseeing a survey of the main Aspen stands for this species in the hope that more colonies await discovery. One of the targets in the Species Action Plan is to ensure that there are 10 viable populations within the historical range by 2010, by enhancing population sizes at known sites or by re-introducing populations to suitable locations (UK Biodiversity Steering Group). *Epione* has not been recorded at Invertromie though parts of the wood look ideal. As Aspen regenerates the area of ideal habitat will increase, making the site a priority candidate as one of the suitable re-introduction locations. One of the main management prescriptions will then be to coppice the Aspen to maintain a continuity of low shrubby Aspen of a suitable height.

In 1999 *Orthotrichum obtusifolium*, was discovered on the bark of a single Aspen tree on the edge of Invertromie Wood. It was then known from only one other site in Scotland but has subsequently been found on four further Aspen trees in adjacent Aspen stands (Rothero, this volume). Mature trees adjacent to these sites will be retained in the hope that *Orthotrichum* may colonise them in the future.

Research and survey work at Invertromie

Invertromie is now becoming an important study site for Aspen and its dependant taxa and several exciting and important discoveries have already been made. Knowledge gained and implemented at Invertromie could prove to be invaluable at other sites where the pressure on Aspen and its associated species are far greater.

One of the most significant discoveries was of the Aspen specific bracket fungus *Phellinus tremulae,* a first for Scotland though it is now proving to be fairly widespread on suitable Aspen trees in the area (Emmett and Emmett 2001; Emmett and Emmett, this volume). As a result of the Aspen seminar, a great deal of interest has been shown in Aspen by lichenologists (Street and

Street, this volume) and a recent survey has revealed four species new to Britain and one previously believed to be extinct, (Coppins *et al.* 2001).

Detailed autoecological work on the Aspen longhorn beetle, (*Saperda carcharius*) presented in these proceedings was based at Invertromie. What was probably Scotland's biggest ever moth trapping night was also held at Invertromie, when members of the British Natural History and Entomological Society ran over 20 light moth traps in Invertromie Wood.

Several studies are in progress focusing on the saproxylic diptera, (dead wood dependant flies), trying to find answers to key lifecycle questions to help guide future management. In contrast to many flies, the requirements of the larval stages of *Hammerschmidtia* are well known compared to those of the adult fly. Little is known about the adult's behaviour or food requirements. The lack of nectar or pollen sources within the wood may be a factor limiting the population. This is currently being monitored through detailed observations in the field. Another crucial unknown concerns the adult's powers of dispersal. This information will prove invaluable in planning and prioritising Aspen connectivity projects and in determining locations for the targeted provision of fresh dead wood in other areas.

The provision and subsequent annual monitoring of fresh dead wood at Invertromie will lead to a better understanding of the exacting larval requirements of the saproxylic fauna. This will help in the determination of timescales and a better understanding of the processes of decay. For example, how long does it take for new fresh dead wood to become a suitable larval breeding media? How long do these conditions persist? What density of larvae can the timber support? Experiments are also in progress trying to create artificial sap runs in Aspen. These occur naturally and are used by both adults and larvae alike. This is currently proving problematic as any sap flow induced is soon healed by the tree. Samples from natural sap runs are being tested to identify bacterial or fungal agents that may be preventing the sap clotting and introduced into artificially created runs in an attempt to keep them open.

The age structure of Aspen at Invertromie is being determined through mapping and coring. This will shed light on the history of the wood as well as quantifying the future resource. The distribution of clones is also being mapped, using both leaf burst and autumn colours to identify clones.

Connectivity

Strathspey Aspen stands occupy a distinct zone, a band that extends from the edge of the floodplain to the base of the heather moorland. The sympathetic management of the present Aspen resource is paramount, but this must only be seen as a short-term measure. The long-term and far greater challenge is to link existing stands, effectively creating Aspen corridors between sites. Several of these stands are isolated, probably with poor genetic variation, such corridors will allow both movement of species and genetic flow (MacGowan, this volume). Some stands are separated by dense conifer plantations that act as an impenetrable barrier despite the closeness of adjacent stands. So, the clearance of some conifers or creation of Aspen rides in these plantations is a high priority. The nearest adjacent Aspen stand to Invertromie lies across the B970 at Torcroy. A priority management objective at Invertromie is to link these two stands by planting an adjoining corridor of Aspen along the perimeter of the adjacent fields.

The distribution of Aspen in Badenoch and Strathspey is presently being mapped and an Aspen database created. This exercise is an essential step if the aim of linking stands is to be achieved, as it will readily highlight sites for the creation of Aspen corridors as well as identifying barriers (MacGowan, this volume). These can then be prioritised and targeted action undertaken by encouraging regeneration or planting to link stands, or creating rides or restructuring plantations to remove barriers.

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Several of the projects described would not have been possible without the financial backing of various bodies including FC, Butterfly Conservation and SNH.

I look forward to the continued use of the RSPB's Invertromie Wood as a research and survey site for all those interested in Aspen, its associated species and ultimately its conservation and discovering more about this wonderful and special habitat with such inspiring people.

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Habitat fragmentation

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One of the main threats to woodland communities throughout the British Isles has been the trend towards a declining percentage of native woodland cover, which has led to our remaining woodlands becoming smaller and increasingly isolated from each other by open space – a process called fragmentation.

Woodland insects associated with dead wood evolved at a time when woodland cover was almost continuous and the amount of dead wood available was probably quite large. As a general rule, they have not developed great powers of dispersal and when they do move to find a new habitat to breed in they prefer to do so at a low altitude through open native woodland habitats following a scent trail of decaying wood.

In native woodlands the wind speeds are relatively low, the humidity relatively high and, with an open structure and varied flowering plants present, there are usually nectar sources available either in the ground vegetation or from the trees and shrubs to provide fuel for insects flying and dispersing. In areas of open ground, wind speeds are higher making the chances of an insect being blown away from favourable habitats much greater, scent trails from decaying wood are also dispersed and more difficult to follow, and nectar sources may be absent or infrequent. Conversely, in areas of dense conifer plantations, although wind speeds are low, the density of the trees may act as an actual physical barrier, suitable nectar sources are absent, and the overwhelming odour of conifer resins may obscure any chance of picking up a scent trail of a decaying native broadleaf. Accordingly, both areas of open ground and of conifer plantations will act as a barrier to the dispersal of woodland insects.

In areas where woodland is highly fragmented, the communities of plants and insects within them are more unstable and more likely to suffer in the short-term from local extinctions and in the long-term from a more general extinction in the wider area. In an area such as Strathspey, a strategic view is required of the Aspen resource to identify which Aspen stands and areas of native woodland are fragmented, and to develop a model of how greater linkages may be achieved. On the ground, this work will probably only proceed on an opportunistic basis as applications for woodland grants are submitted or opportunities arise for the restructuring of commercial conifer woodlands, but the development of a model should predict which areas have the highest priority for such action.

Habitat fragmentation case study - Balliefurth

The map (centre page insert) shows that the important Aspen stands at Grantown (shown in red) and the open Birch/Aspen wood matrix (shown in orange), through which it is probable that the rare Aspen hoverfly *Hammerschmidtia ferruginea* can disperse, are almost encircled by commercial forestry (shown in green) This applies in particular with regard to the route down the Spey to the south, which leads initially to the stand at Culreach and thence on to the other important Aspen stands in Strathspey.

In order to improve the long-term survival prospects for *Hammerschmidtia* and other Aspen specialist species as part of a long-term strategic approach to creating linked woodlands in Strathspey, consideration should be given to the removal of the conifer blockage caused by Balliefurth Wood and for its replacement, at least in part, by an open woodland dominated by native broadleaf species.

This, in conjunction perhaps with some additional planting of broadleaves along field boundaries, should in time create a linkage to the Culreach stand, which with a good stock of mature Aspen trees could provide suitable dead wood habitat. As a first step in a long-term process, this would allow the major Aspen stands at Grantown to be more effectively connected to other Aspen stands in Strathspey.

Aspen in myth and culture

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Why include a paper on the myth and culture of Aspen in the proceedings of a conference about Aspen biodiversity and management?

Put simply, we should not lose sight of the fact that Aspen has survived best in areas where it is valued by the people who live there, and it will only continue to survive, and spread, with their help. People value Aspen for many reasons, but the two main ones are its landscape and its cultural value. In Badenoch and Strathspey the golden autumn colours of aspen are stunning, and it contrasts beautifully with the bronze of the Birch and the sombre green of Scots pine. The cultural value of wildlife is often overlooked, but I would suggest that it is as integral a part of its value as its scientific interest.

The word Aspen derives from the Old English *aespe or aepse*, which is related to *aspe* in German, *asp* or *baevreaspe* in Danish and Swedish and *osp* in Norwegian. The alternative names *zitterpappel* in German and *ratelpopulier* and *trilpopulier* in Dutch, all mean '*quaking poplar*' (Edlin 1964).

In Gaelic, Aspen is *critheann*, or *critheach*. The origin is *crith*, meaning to shake or quiver. The saying '*Critheann san t-sine*' means '*like an Aspen in the blast*' (Dwelly, 1998). In the Gaelic language, the letters of the alphabet are represented by trees, and Aspen signifies the letter E, '*eubh*'. The derivation of this practice is uncertain,but it is thought that it may have acted as a teaching aid in the oral tradition, prior to the introduction of the standardised, Latin alphabet. Eighteen tree and shrub species are used to represent 18 letters or sounds (Edlin, 1950)*.

In Irish, Aspen is *arann-aritheach* (McBain, 1982) or *criteac* and *eada* (Edlin 1964). In Early Irish, it is also *crith* (McBain, 1982). Aspen is also given several names in Welsh, where the proper name is *aethnen* (Edlin 1964) or *aethnea* (Nodine 1995). McBain (1982) states that in Welsh it is *cryd*, and in Old Welsh, *cirt*. Two Welsh colloquial names are *coed tafod merched* and *coed tafod gwragedd*, both meaning '*the tree of the woman's tongue*' (Edlin 1964).

Aspen is occasionally called the *'quaking tree'* in Badenoch and Strathspey (various *pers. comm.*), or elsewhere in Scotland *'quaking ash'* or *'old wives' tongues'* (Jonathan Willet, *pers. comm.*). Aspen's Latin name is *Populus tremula*, which is the name for the family, *Populus*, and from the Roman *tremula*, meaning to tremble, or shake (Edlin 1964).

Aspen is occasionally referred to as an element in place names. Crianlarich is possibly the 'Aspen tree (*critheann*) of the ruined house (*lariach*)' (Darton, 1994). A Gaelic name for Aspen, *crann critheach*, has given rise to Killiecrankie, *'wood of the Aspens',* in Perthshire. In Sutherland, Ospisdale is thought to mean *'Aspen valley'* (Edlin 1964). In England, Aspen is found as a place name element in Aspenden in Hertfordshire, meaning valley where the Aspen trees grow, from Old English *aespe* and *denu*. Similar cases arise with Aspley in Bedfordshire, meaning *'Aspen wood or glade',* and Aspull in Greater Manchester, meaning *'hill where the Aspen trees grow'* (Mills, 1991). Espley in Northumberland and another Aspley, in Warwickshire, are further examples (Edlin 1964).

The Greek name for Aspen is *aspis*, and means shield. The Celts apparently used Aspen timber for making shields, and these shields were more than mere physical barriers between warrior and enemy; they were imbued with additional magical, protective, qualities to shield the bearer from psychic as well as physical harm. The magically protective nature of the *'shield tree'* extended to the general population too and Aspen, like the rowan tree, was a popular choice of tree to plant close to a dwelling (Trees for Life 2001). However, this may not have been the only reason why Aspen was planted or encouraged next to settlements. When taken in concentrated form, the bark of Aspen is reputed to have abortive properties and this may have been used to terminate unwanted pregnancies in rural communities (Peter Cosgrove, *pers. comm.*).

Elsewhere, Aspen appears to have had a rather negative reputation. '*The people of Uist say that the hateful Aspen is banned three times. The Aspen is banned the first time because it haughtily held up its head while all the other trees of the forest bowed their heads lowly down as the King of all created things was being led to Calvary. And the Aspen is banned the second time because it was chosen by the enemies of Christ for the Cross upon which to crucify the saviour of mankind. And the Aspen is banned the third time because….(here the raconteur's memory failed him). Hence the ever-tremulous, ever quaking motion of the guilty, hateful Aspen even in the stillest air. Clods and stones and other missiles were hurled at Aspen by the local people. The reciter, a man of much natural intelligence, said that he always took off his bonnet and cursed the hateful Aspen with all sincerity wherever he saw it. No crofter in Uist would use Aspen about his plough or about his harrows, or about his farming implements of any kind. Nor would a fisherman use Aspen about his boat or about his creels or about any fishing gear whatsoever*' (Carmichael 1997)*.

The understanding in the Highlands of Scotland that Christ's cross was made from Aspen appears to be longstanding. In 1777, Lightfoot wrote '*The belief amongst eighteenth century Highlanders, that the crucifix was made from Aspen, was evidenced by the fact that the leaves are always restless*'.*

Aspen has an interesting place in religious superstition of the Highlands. Until recently, it was thought that the sound of the leaves rustling in the wind was able to induce prophetic insight (although Highland men were known to draw an analogy between the sounds and the incessant chatter of their wives!). This perhaps reflects early, Pre-Christian beliefs – the same that might be responsible for the taboo on this plant's use in farming or fishing. In Christian belief, the plant was cursed – a Gaelic saying translates to "*Malison be on thee, O Aspen cursed, on thee was crucified the king of kings*" (Fife, 19??).

According to the Trees for Life website, folk taboos, including those against the use of Aspen for fishing or agricultural implements, or for house building, suggest that Aspen may have been considered a faerie tree on a par with rowan, which has similar taboos. Trees important to pagan religions appear to have been deliberately demonised in later, Christian, teaching.

Despite these negative associations, Aspen did have some specific uses:

- Its wood was used for making matches and arrows, and as a source of timber for gunpowder charcoal.
- The wood was reputedly used for teething rings in some parts of the Highlands, as the wood of the cross was sacred (Jonathan Willet, *pers. comm.*).
- Its timber is very lightweight when dried, and very buoyant, so it was used for oars and paddles. Its lightness also made it suitable for wagon bottoms and for surgical splints. Its softness and lightness, though ideal for sculpting, are not suitable for use in building, though floorboards were sometimes made of Aspen as a safety measure, as Aspen wood does not burn easily (Trees for Life).
- Aspen was the badge of Clan Ferguson according to some (Dwelly 1998).
- It gives a yellow dye (Thompson, 1969)* and a black dye from the young leaves, and brown dye from the bark (Jonathan Willet, *pers. comm.*).
- The Bach Flower Remedies recommend extracts of Aspen to treat fears and apprehensions (Trees for Life).

- Aspen leaves, bark and shoots are very palatable to grazing animals, and according to Trees for Life, hand gathered Aspen leaves were fed to cattle when other food was scarce.

This short paper demonstrates some of our cultural responses to Aspen. The strength of this response perhaps reflects its importance in the landscapes in those areas where it occurs in any numbers.

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Trees for Life, at www.treesforlife.org.uk, is an interesting web site for information on Aspen and trees in general.

Delegate discussion

At the end of the conference, there was an open discussion on some of the issues arising from the day. The following points (in no particular order) were made by delegates:

1. Peter Quelch suggested a brain storming day be held by interested parties to take Aspen action forward amongst the partners after the conference.
2. Jonathan Willet thought it would be worthwhile drawing up a list of Aspen related databases held by each group, which could be accessed by all interested parties. He also thought that a structured plan and guidelines for Aspen management would be beneficial rather than the current *laissez faire* approach.
3. Alan Finnes suggested an Aspen Action Group be formed to act as a central collection point for information and to draft any plans thought necessary. Trees for Life offered to be an active partner should the group come to fruition.
4. Anne Elliott highlighted the importance of grazing on Aspen woodland and suggested that this be considered and incorporated into any future management plans.
5. Sandy Coppins felt that the pasture woodlands at Insh should not be considered as secondary woodland but are remains of ancient woodland and are therefore of high interest.
6. Dave Phillips hoped that agri-grazed wood-pasture would be considered in the WGS Review.
7. Colin Forrest was interested to know of any nurseries that supplied local provenance Aspen. He also suggested that there be an information exchange between interested groups. Adam Powell said that Trees for Life held a vast amount of data which they had accumulated from various surveys and this could be made generally available.
8. Robin Noble asked that if there was to be a repeat of the Aspen day that it be held in Assynt, where there is 50 years of Aspen regeneration to look at.
9. Denis Torley put forward the idea of restructuring existing conifer plantations for broadleaf components and thereby increasing the opportunities to expand Aspen.
10. Peter Quelch felt that there needed to be a surplus of Aspen to create new stands and had heard of a small nursery www.treetrader that may help.
11. Adam Powell suggested Christie Elite in Forres as a reputable nursery who might be able to supply locally sourced Aspen. Trees for Life are propagating Aspen and techniques are available from Adam.
12. Allan Stevenson suggested trying to build Aspen into the present Birchwood habitat action plan, he felt it would be difficult to prove this was a worthy cause on its own. Forest Enterprise have a broadleaf commitment to all their plantings and he felt the conference was exceptionally good and should be repeated in the future.

The Biodiversity and Management of Aspen Woodlands

Friday 25th May 2001

at The Duke of Gordon Hotel, Kingussie

Delegates list

First name	Surname	Organisation
Andy	Amphlett	RSPB
Chris	Badenoch	Scottish Natural Heritage
Barbara	Ballinger	
Brian	Ballinger	
Dave	Batty	Scottish Natural Heritage
Peter	Beattie	Scottish Natural Heritage
Willie	Beattie	Forestry Commission
Tracey	Begg	RSPB
Claire	Belshaw	Culag Community Woodland Trust
Saranne	Bish	Highland Council Ranger Service
Keith	Bland	
Stephen	Brown	Forestry Commission
David	Brown	Borders FWAG
Jenny	Bryce	Scottish Natural Heritage
Brendan	Callaghan	Forest Enterprise
Iain	Calvert	Scottish Woodlands Ltd
David	Carstairs	Scottish Natural Heritage
Ian	Collier	Forestry Commission
Brian	Coppins	Royal Botanic Garden
Sandy	Coppins	Consultant Lichenologist
Peter	Cosgrove	Cairngorm LBAP Officer
Debbie	Cowan	Tayside Native Woodlands
G S	Cross	Macro Forest
Claire	Cummings	Trees for Life
Meg	Dickens	RSPB
Chris	Donald	RSPB
Joanna	Drewitt	Scottish Executive
Claire	Dumigan	Fife Ranger
Keith	Duncan	Scottish Natural Heritage
Siobhan	Egan	RSPB
Anne	Elliott	Scottish Natural Heritage
Ernest	Emmett	Mycologist
Valerie	Emmett	Mycologist
Richard	Ennos	Edinburgh University
Philip	Entwistle	
Hugh	Fife	Reforesting Scotland
Tanya	Fletcher	BTCV Scotland
Colin	Forrest	Tayside Reforesting Enterprise
Mark	Foxwell	Scottish Wildlife Trust

First name	Surname	Organisation
Ian	Francis	RSPB
Robert	Furness	Seafield & Strathspey Estates
Paul	Gallagher	Scottish Wildlife Trust
Claire	Geddes	
Diana	Gilbert	Highland Birchwoods
Patrick	Green	Forestry Commission
Viv	Halcrow	
Geoff	Hancock	University of Glasgow
Alan	Harper	Forestry Commission
Liz	Holden	
Eric	Jackson	RSPB
Gus	Jones	Scottish Wildlife Trust
Paul	Kendall	Trees for Life
Anne	Kiggins	Scottish Natural Heritage
Paul	Kirkland	Butterfly Conservation
Russell	Lamont	Forestry Commission
Melissa	MacCosh	Scottish Natural Heritage
Iain	MacGowan	Scottish Natural Heritage
Janette	MacKay	North Highland Forest Trust
James	MacKenzie	Shetland Ammenity Trust
Morag	MacKenzie	RSPB
Neil	MacKenzie	
Peter	MacKenzie	Badenoch Land Management
Ruth	Maier	RSPB
David	Mardon	National Trust for Scotland
Bill	Mason	Forest Research
Graham	McBryer	Forestry Commission
Jamie	McIntyre	Forest Enterprise
Alison	McKnight	Cairngorm FWAG Officer
Pete	Moore	Scottish Natural Heritage
Pete	Moore	RSPB
Sam	Murray	Reforesting Scotland
Kenny	Nelson	Scottish Natural Heritage
Ros	Newton	RSPB
Robin	Noble	
Dave	O'Hara	RSPB
John	Parrot	Scottish Native Woods
David	Phillips	Scottish Natural Heritage
Mollie	Porter	Highland Council Countryside Ranger
Adam	Powell	Trees for Life
Ross	Preston	Forest Enterprise
Tom	Prescott	RSPB
Neil	Proctor	Forestry Commission
Peter	Quelch	Forestry Commission
John	Risby	Forest Enterprise
Carol	Robertson	North East Native Woodlands

First name	Surname	Organisation
David	Robertson	
Graham	Rotheray	National Museum of Scotland
Gordon	Rotheroe	Bryologist
Alan	Ross	Scottish Nature
Hamish	Robertson	CKD Findlayson Hughes
Hannes	Schnell	RSPB
David	Shepherd	
David	Sheppard	English Nature
Malcolm	Smith	I.G.Smith & Partners
Alan	Stevenson	Forestry Commission
Les	Street	RSPB
Sheila	Street	Lichenologist
Ron	Summers	RSPB
Jenny	Taylor	Orkney Native Tree Group
Stuart	Taylor	RSPB
Denis	Torley	Forest of Spey Officer
Una	Urquhart	Marchfield Ecology
Richard	Wallace	Forestry Commission
Stephen	Ward	Scottish Natural Heritage
Alan	Watson Featherstone	Trees for Life
Ken	Watt	
Britt-Maire	Wenner	
Miles	Wenner	Forest Enterprise
Dave	Whitaker	Forest Enterprise
Jonathan	Willet	Biodiversity Officer, Stirling
Duncan	Williams	
Scott	Wilson	Consultant Forester & Ecologist
Esther	Woodward	Crannach Management Group
Paul	Young	Woodland Trust Scotland
Mark	Young	University of Aberdeen